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AN ANALYSIS OF THE NEED
FOR A
COAST GUARD SEARCH AND RESCUE FACILITY

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Monterey, California

THESIS

An Analysis of the Need
for a
Coast Guard Search and Rescue Facility

by

Kenneth Claude Hollemon

Thesis Advisor: S. H. Parry

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air station was simulated. The study indicated that the air station will reduce response time to maritime SAR incidents 15 to 25 minutes without considering possible delays caused by low visibility at the Arcata airport. Additional study in specific areas was recommended.

An Analysis of the Need for a Coast Guard Search And Rescue Facility

by

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Lieutenant, United States Coast Guard
B. S., United States Coast Guard Academy, 1966

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ABSTRACT

This study is a step-by-step process for examining the need and probable effectiveness of new Coast Guard SAR facilities. The vehicle for the study is a proposed Coast Guard Air Station to be located at Arcata, California, but the process is adaptable to any locale or any type of SAR facility. Data from historic SAR incidents was analysed and the SAR environment of the area to be served by the air station was simulated. The study indicated that the air station will reduce response time to maritime SAR incidents 15 to 25 minutes without considering possible delays caused by low visibility at the Arcata airport. Additional study in specific areas was recommended.

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I. INTRODUCTION

Probably the most well-known role of the United States Coast Guard is that of Search and Rescue (SAR). Originally the Revenue Marine Service considered SAR as a collateral duty, but by 1837 its ships were actively cruising the coasts of the United States in order to locate and assist mariners in distress. Another organization, the U.S. Lifesaving Service, also had a long and notable record of saving crewmen whose ships had gone aground. In 1915 these two services were merged to form the U.S. Coast Guard, and SAR was a tradition of long standing that was incorporated into the duties of this new service.

This tradition is codified into the laws of the United States in the United States Code as follows:

> 14 USC 2 "The Coast Guard . . . shall develop, establish, maintain, and operate . . . rescue facilities for the promotion of safety on, under, and over the high seas and waters subject to the jurisdiction of the United States . . . ."
>
> 14 USC 88 "In order to render aid to distressed persons, vessels, and aircraft on and under the high seas and on and under the waters over which the United States has jurisdiction and in order to render aid to persons and property imperiled by flood, the Coast Guard may perform any and all acts necessary to rescue and aid persons and protect and save property." "The Coast Guard may render aid to persons and protect and save property at any time and at any place at which Coast Guard facilities and personnel are available and can be effectively utilized."
>
> 14 USC 141 " The Coast Guard may, when so requested by proper authority, utilize its personnel and facilities to assist any Federal agency, State, Territory, possession, or political subdivision thereof, or the District of Columbia, to perform any activity for which such personnel and facilities are especially qualified."

In order to perform its Search and Rescue mission, the Coast Guard must allocate personnel and equipment resources to various locations around the United States to provide its services when needed by persons or property in distress.

Because the Coast Guard SAR mission is primarily concerned with the saving of life and property after a distress situation develops, SAR is strongly time oriented. The longer a person or his property is exposed to a hostile environment, the greater are the chances that an incident will turn into a disaster, resulting in the loss of life and/or property.[1] For this reason, the time for a Coast Guard unit to respond to a distress presents a simple measure of effectiveness for its SAR activity.

It is conceivable, of course, that sufficient resources could be made available in the Coast Guard budget to ensure that a Coast Guard unit would arrive at the scene of any distress within any given time increment anywhere in the United States. As the specified time increment decreases and the distance from the "home" location of the Coast Guard resources to the position of distress increases, the shorter response time entails additional costs. Eventually, the marginal improvement in response becomes prohibitively expensive.

There is some difficulty in defining an acceptable response time for SAR. One effort to define such a time increment was given for Coast Guard aviation units as follows:

> "SAR aviation units shall, within the Harbor and Coastal Zone, be capable of flying to the scene of 75 percent of the assistance cases within one-half hour and 90 percent within one hour and be capable of recovering (rescuing) persons in distress." [2]

The Harbor and Coastal Zone was defined in the Coast Guard Aviation Plan as being the zone including rivers, bays, and inlets out to 150 miles seaward.

The allocation of scarce SAR resources is an important facet of the Coast Guard's SAR role. Resources must be

stationed to ensure that they can be economically operated and are suited to the natural and SAR environment of their assigned area while still achieving the desired level of response. At the same time, care must be exercised to avoid positioning too many resources in any area. This results in "overkill", inefficiencies, and additional expenses. In order to properly determine the optimum type and mix of resources, their location, and their manning levels, an analysis should be made of all factors bearing on their activities in an operating area. The analysis should investigate probable numbers and types of distress incidents requiring assistance by Coast Guard resources, the natural environment, complimentary search and rescue resources in the area, and any other pertinent factors.

The purpose of this thesis was to supply an example of such an analysis to the needs for Coast Guard search-and-rescue resources in an area of Northern California. The analysis was directed toward determining if an additional SAR resource was required in the area -- an air station at the Arcata-Eureka Airport. It was written, however, in such a manner that it could be applied to any change in Coast Guard resources for any area.

The current plan, as promulgated in Part Two of the Coast Guard Aviation Plan (CG-380-2), is to establish an air station at Arcata with three HH-52A helicopters in FY 1978, budgetary limitations permitting. The rationale for the new air station is presented below:

> "Since FY 1963 there has been a substantial growth in the number of SAR cases within a radius of 75 miles of the Humbolt Bay area of Northern California. Case totals have increased 24% in ten years [sic], from 182 in FY 1963 to 449 in FY 1972. The distance from the nearest om 182 in FY 1963 to 449 in FY 1972. The distance from the nearest Coast Guard air units precludes our ability to provide timely response with adequate recovery capability. San Francisco Air Station is 210 miles to the south and Astoria is 325 miles north of Humbolt Bay. Even with the establishment of North Bend Air Station in FY 1974 the nearest aircraft response (HH-52A's) will still be 165 miles away, almost a

> two-hour flight from Coos Bay.
>
> The National Planning Association's "Marine Activities Forecast" for Northern California appears conservative for the Humbolt Bay region; their FY 1980 workload projections may well be upon us in the early 1970's.
>
> Public, private, and political pressure has already been exerted to bring Coast Guard rescue aircraft to the Humbolt Bay area; in fact in 1966 Humbolt County authorized 12.8 acres of land at the Arcata County Airport for Coast Guard use on the condition that a helicopter base be located at said airport. A reasonable case for establishing such a unit can be generated on the basis of the increase in SAR case load, analysis of the nature of Coast Guard surface unit responses in that area, and projected growth."[3]

Two mission areas of the Coast Guard were forecasted for the proposed station. They were SAR and Enforcement of Laws and Treaties.[4] This station is rather unique in that it is to have such a limited number of mission areas as its responsibility, a fact which greatly simplifies analysis.

Because of its emphasis on the Search and Rescue role, the Coast Guard has developed a standardized reporting system to support this program. Each time a Coast Guard facility is used to aid persons or property the responsible Coast Guard official is required to submit an Assistance Report (CG 3272). The format of this report has changed several times over the years but, essentially, the same information is reported in each. A complete description of the property in distress is given, including the cause of distress. "Nature of Distress" is a term which is used in the Assistance Report to indicate the problem encountered by the persons or property that requires Coast Guard assistance. One example of nature of distress is "vessel disabled and adrift." Another is "personnel injury." When the Coast Guard receives a report that its assistance is required, the nature of distress is one important consideration used to determine which resource to dispatch to aid in the situation. Further information includes a brief description of the weather encountered along with the absolute position and the position of distress relative to

the responding Coast Guard facility. For the purpose of the thesis, these items which are essentially beyond the control of man are termed "states of nature." In addition, significant times are recorded, along with the actions of the Coast Guard facility. Finally, the relative success of the actions of the Coast Guard is reported in terms of lives saved, helped, or lost and the value of property assisted. These data are compiled and stored in Coast Guard Headquarters for subsequent use in analysis and decision making. A sample Assistance Report is included as Appendix A.

The Assistance Reports for Northern California, as transcribed to the permanent Coast Guard records, formed the data base for this thesis. Originally the data was in the form of cards obtained from the Twelfth Coast Guard District. This data was complete in that it contained all entries from the Assistance Reports for the years 1971 through 1973. Later, additional data was received in the form of cards for the years 1970 and 1974 from Coast Guard Headquarters. This data had been transcribed from file tape to cards. The data was not complete in that all the data submitted on the Assistance Report was not included. The information concerning month of distress, position of distress, and time of day was missing from this data. When data was missing from some years, that fact was indicated in the analysis chapter of the thesis.

II. AREA STUDY

The term used to describe the geographical region to be serviced by the proposed Coast Guard facility was "area of interest." This area of interest should be large enough to include the normal operations of the Coast Guard facility, taking into account other Coast Guard units in the area, geographical considerations, and limitations imposed by the type of Coast Guard resource being considered. For the proposed Coast Guard Air Station at the Arcata-Eureka airport, the area of interest was defined as that region between 40-00 and 42-00 North Latitude and between the mountainous region approximately thirty miles inland from the coastline to 300 miles offshore. Latitude 42-00N is the position of the California-Oregon border and forms the boundary between the Twelfth Coast Guard District and the Thirteenth Coast Guard District. The region measures approximately sixty miles north and south and more than 300 miles in its east-west dimensions.

The most significant maritime feature in the area of interest is Humbolt Bay, which is a large sheltered bay and the third largest natural harbor in California. It is the most important harbor on the west coast between San Francisco and the Columbia River. The cities of Eureka and Arcata are located near this bay. Eureka is the third most valuable fishing port in California. The major industry for Arcata is lumbering and lumber products. A third important town in the area of interest is Crescent City, located approximately forty miles north of Humbolt Bay. The major industries in Crescent City are lumbering and dairying.

Two large river systems empty from inland regions into the ocean in the area of interest. The more important one, the Klamath River, empties approximately 30 miles north of

Humbolt Bay. This river is important because nearly one-third of the incidents involving boaters within the area of interest occurred within five miles of its mouth. The Eel River ends approximately five miles south of Humbolt Bay. Although few boats are assisted by the Coast Guard near this river, it has flooded during various years and Coast Guard forces have participated and assisted local authorities in flood relief operations.

A description of the geography and climate in the area of interest is provided by the Department of Commerce Local Climatological Data description:

> "There are no hills in Eureka of any consequence. The land slopes upward gently from the Bay towards the Coast Range, which begins about 3 miles east of the station (Eureka) and reaches the top of its first ridge approximately 10 miles to the east. The average elevation of the ridge is about 2,000 feet. This ridge extends in a semi-circle from a point 20 miles north of Eureka to a point 25 miles south.
>
> The climate of Eureka being completely maritime, high humidity prevails the entire year, which is divided into the "rainy" season and the "dry" season. The rainy season begins in October and continues through April. About 90 percent of the year's precipitation falls during this period. The dry season extends from May through September and is marked by considerable fog or low cloudiness. Usually, however, the fog clears in the late forenoon with the early afternoons generally sunny.
>
> Temperatures are moderate the entire year. Although the highest ever recorded was 85 degrees, and the lowest 20 degrees, the usual range is from a low of about 35 degrees to a high of about 75 degrees. The daily range of temperature averages from about 9 degrees in the summer months to 13 degrees in the winter months, and is occasionally not over 2 to 3 degrees."[5]

The temperature of the waters offshore in the Eureka area range between 50 degrees and 55 degrees Fahrenheit.

The area of interest includes portions of two counties of California, Humbolt County and Del Norte County. The total number of boats registered in these two counties for the years 1970 through 1974 were:

1970	1971	1972	1973	1974
2037	2919	4203	4773	5232

The low figures for 1970 and 1971 were due to the fact that a change in the registration procedure took place between those years and subsequent years. Typically, 77 to 78 percent of the registered boats are registered in Humbolt County. No information was available for the number of documented vessels in the area.

Data was not made available which gave detailed information concerning the lengths of the vessels in Humbolt and Del Norte counties. The usage of those vessels which were registered also was not given. The state-wide distribution of lengths of registered boats was reported as follows:[6]

	1970	1971	1972	1973	1974
Less than 16 feet	64.0%	61.5%	60.5%	58.2%	57.5%
16 feet to 26 feet	32.0%	32.5%	34.0%	36.2%	36.9%
26 feet to 40 feet	4.5%	4.5%	5.0%	5.0%	4.9%
40 feet to 65 feet	0.5%	0.5%	0.5%	0.6%	0.7%

The number of Search and Rescue incidents answered by the Coast Guard in the area of interest during the Fiscal Years 1970 through 1974 was 1650, including multi-unit cases in which more than one Coast Guard resource answered a call for distress. The data from some of these cases was unusable, resulting in the discarding of some of the incident reports. Such unusable data included reports for which the severity to personnel or property was coded as unknown, data in which the position of distress was coded as unknown, or data which was incomplete. Culling of such

erroneous data left a total of 1468 cases for five years. The number of cases occurring in any year is given as follows:

1970	1971	1972	1973	1974
327	264	360	195	322

The distribution of lengths of vessels assisted by the Coast Guard during the five years were:

Not a Vessel	3.4%
Less than 16 feet	32.2%
16 feet less than 26 feet	15.4%
26 feet less than 40 feet	21.5%
40 feet less than 65 feet	20.5%
65 feet less than 100 feet	2.6%
100 feet less than 200 feet	1.1%
200 feet less than 300 feet	0.2%
Greater than 300 feet	2.0%
Unknown	1.1%

The distribution of the usages of the vessels assisted during those years was:

Recreation	47.4%
Fishing	43.5%
Towing	1.0%
Cargo	1.6%
Other	1.4%

No other code for usage appeared more than one percent of the time. The figures do not total 100% because in the Assistance Report a usage code can be assigned to cases other than vessels. During the five years there were approximately 13 cases involving aircraft, 3 cases involving land vehicles, 5 cases involving land structures and 47 cases involving personnel only in the area of interest. Charts representing the geographic distribution of historical SAR cases are included in Appendix F.

Most of the Coast Guard facilities now rendering search and rescue services in the area of interest are under the command and control of Group Humbolt Bay, which reports to the Twelfth Coast Guard District. The medium-endurance cutter COMANCHE (WMEC 202), home-ported in Eureka, is also under the direct control of the District Headquarters. Included in the facilities of Group Humbolt Bay are the 95-foot WPB CAPE CARTER, ported in Crescent City and two 44-foot MLBs stationed in Eureka. During the salmon season, from approximately 1 July to 15 October of each year, the boating traffic on the Klamath River rises dramatically. Swift river currents and the interaction of the ocean swell

causes hazardous conditions on the river. During this period, Station Klamath River is established with a complement of approximately six men and trailerable 25-foot and 17-foot boats.

Coast Guard air support for the area of interest is currently provided by the Coast Guard Air Station at San Francisco International Airport. That location is approximately 210 miles away from Eureka via Federal Airways. A HH-52A helicopter requires approximately three hours to reach the Arcata-Eureka airport from San Francisco and requires refuelling prior to continuing on a SAR case. A fixed-wing HC-130 or HU-16 aircraft from San Francisco can be over Eureka approximately one and a half hours after notification.

Single-engined HH-52A helicopters are limited in their operations and must remain within 25 miles of the shoreline unless they are escorted by fixed-wing aircraft, in which case they are limited to 100 miles offshore. On several occasions, especially in cases requiring medical evacuation of seriously-injured or critically-ill persons, HH-3F helicopters from the Coast Guard Air Station at Astoria, Oregon or San Diego, California were flown to Eureka by one crew and the medevac mission was performed by a second crew. The time required to fly a helicopter to Eureka is approximately four hours. HH-3F helicopters can perform missions up to 300 miles offshore. Assistance to personnel or to property greater than 300 miles offshore must be provided by surface vessels or by air dropping equipment or people from fixed-wing aircraft. These aircraft can, of course, assist vessels which are not more than 300 miles offshore in a similiar manner.

In addition to the Coast Guard units in the Eureka area, there are other resources which are used for search

and rescue, particularly for incidents on the land. The Humbolt County Sheriff's Department reports that it responds to approximately thirty inland SAR incidents per year, and that this number does not appear to be growing. The Sheriff's Department calls upon the Civil Air Patrol, the Ski Patrol, the Marine Posse, the Jeep Patrol, and the Mounted Posse to assist in inland SAR incidents. It requires approximately three hours between notification and the time a Civil Air Patrol unit is available, weather permitting.[7] The Forest Service reportedly has use of a small helicopter which they operate in the area during the summer months. All these resources have worked together with Coast Guard units in the past, both in operations along the coastline and overland.

An important aspect of the study of the effectiveness of a Coast Guard air station is the weather. Having an air station in an area serves no purpose if the aircraft stationed there are grounded in fog. The Coast Guard Air Operations Manual (CG-333) specifies the minimum ceiling and visibility requirements for Coast Guard aircraft departing an airfield. In the case of a single-engined helicopter at Arcata airport, the appropriate criteria are those for airfields with a departure alternate, as defined in the Air Operations Manual, since an airfield at Crescent City has a precision instrument approach where the helicopter could land if necessary. This airfield is approximately forty minutes flying time away from Arcata. If the weather for this airfield is forecasted to be 600 foot ceiling with two miles visibility for one hour and forty minutes after takeoff, the Coast Guard helicopter could depart Arcata if the visibility there is at least one-fourth mile or 1600 feet visibility (RVR 16). An exception is granted "When the immediate urgency of the mission dictates . . . Due consideration must be given to equipment capabilities, alternate field availability, and the circumstances

constituting the urgent requirement."[8]

In 1968 the National Bureau of Standards published a report of the low visibility conditions at the Arcata airport for the period 1957 through 1967.[9] Here follows one interpretation of that report as it applies to the proposed air station at Arcata.

The visibility at Arcata airport was reported as being below 2100 feet by day or 4300 feet by night (defined in the report as "low visibility") as the number of hours per month. The yearly average varied between a low of 26.3 to a high of 63.3, with the number of nighttime hours approximately double the number of daytime hours in most cases. The greatest number of low-visibility hours occurred in the July-January semi-annual period. The greatest number of low-visibility hours for any month were September or October, a period in which approximately eighteen percent of the historic SAR incidents occurred.

The report contained the summary of a three-year Runway Visual Range (RVR) study. The times during which RVR was less than 1000 feet had a mean of 0.28 hours and a median of 0.08 for day periods and a median of 0.15 for night periods. The times ranged as high as 8.3 hours. In a table of times during which the RVR was below 1000 feet, the periods of low visibility seemed to be centered between approximately one hour before sunrise and noon and between one hour before sunset and midnight. Approximately forty percent of the historic SAR cases were during these hours and they had almost a uniform distribution of occurrences between the hours of 0800 and 1800 local time.

While the exception to the takeoff minimums in the case of an urgent mission permits a Coast Guard helicopter to take off in low-visibility conditions, the effectiveness of

that aircraft is severely reduced in very low visibility. Approximately ten percent of the historic SAR cases occurred in reported visibilities of less than one-half mile. The effect of the weather at Arcata -- both low ceilings and low visibilities -- upon operations of the proposed air station deserves further study.

III. ANALYSIS OF HISTORIC STATISTICS

The Coast Guard now has facilities located so as to be able to respond to incidents in virtually all portions of the waters near the seacoast of the United States. As Coast Guard units respond to calls for assistance in any given area, the Assistance Reports these facilities submit represent a sample of the conditions which will be encountered by a new Coast Guard facility located in that area. One of the first steps in analysing the need for a new Coast Guard facility in a given area is to examine the data available in the Coast Guard records.

The Coast Guard SAR data readily lends itself to being represented in frequency distributions. The frequencies of the coded data are made discrete rather than continuous by the coding process. Rather than reporting the exact distance offshore that an incident occurs, for example, the reporting facility fits the distance offshore into one of the ten codes (numbers zero to nine) and reports this coded number. The process of translating the distances offshore, which are continuous, into coded values causes the distribution of the data to become discrete. In order to facilitate analysis, the discrete distributions of the data can be graphically represented in histograms. Frequency distributions for weather conditions, nature of distress, month and time of distress, and distance offshore of distress for the data from the Arcata area of interest are given in Appendix B.

The characteristics of these frequency distributions are descriptive statistics. A very useful statistic is the mean, or the average value, of the observations. There are several useful tests concerning the means of the data which can be performed using both the data from the area of interest and the data from the Coast Guard as a whole.

The means of the code values for the data for the five years are tabulated below. The data which are tabulated are those elements of the SAR environment which occur randomly. This data included multi-unit case data in which a small percentage of observations were duplicated because more than one unit was reporting the same data.

TABLE OF YEARLY MEANS
HISTORICAL DATA

	1970	1971	1972	1973	1974
Nature of Distress	7.8226	10.6932	5.3889	10.5487	6.7019
Distance Offshore	1.3639	1.5795	1.2972	1.7333	1.3043
Personnel Severity	1.5260	1.5455	1.3083	1.3538	1.2143
Property Severity	1.5474	1.4356	1.3056	1.3385	1.1553
Sea State	2.1284	2.4583	2.0361	1.7949	1.6553
Wind Velocity	1.4648	1.8295	1.0611	1.4359	1.2547
Visibility	4.4924	4.7992	4.4444	4.4974	4.6584
Length	2.6911	2.9697	2.1944	2.9744	2.2547
Time of Day	12.8838	12.5985	12.3472	13.3436	13.2516
Month		6.3385	7.5472	6.8485	

The means of the data were compared to determine if the values of the means are statistically the same from year to year. By analysing the data, it may be possible to detect trends such as cases occurring further offshore each year. Patterns such as severity to property being significantly greater than severity to personnel may also be revealed.

In order to examine the data for five years, a one-way analysis of variance of corresponding means was performed. The hypothesis being tested is that the means in each row of data are jointly equal. The implicit assumption was made

that the distribution of the means of the data was normal in all cases. The alternate hypotheses, in the notation presented in Bolch and Huang [Ref. 1], are shown as:

$$H_0: u._1 = u._2 = u._3 = u._4 = u._5 = u..$$

$$H_1: \text{Not all column means are equal}$$

The appropriate test was Fisher's F-test in which the F-statistic is computed as a ratio as follows:

$$F = \frac{\text{Between-Column Variance}}{\text{Within-Column Variance}}$$

This test was performed using the Biomedical Computer Program BIMED01V [Ref. 2] on the IBM 360/67 at the Naval Postgraduate School. The resulting F-ratio was compared with a standard table of percentage points for the F-statistic with four and infinite degrees of freedom at the 0.95 confidence level to determine if all the columns were equal. If the computed ratio of F was greater than the tabulated critical value of F, the null hypothesis was not accepted and it was assumed that the means of the data for the five years were different from year to year. The results of the test are tabulated below:

ANALYSIS OF MEANS
(DATA FOR FIVE YEARS)

	F-ratio Computed	F-statistic Critical
Nature of Distress	3.66	2.37
Distance Offshore	7.79	2.37
Severity to personnel	12.18	2.37
Severity to Property	12.07	2.37
Sea State	8.06	2.37
Wind Velocity	10.44	2.37
Visibility	1.64	2.37
Length of Vessel	14.52	2.37
Time of Notification	2.24	2.37
Month (3 years)	19.19	3.00

In every case except visibility, the test indicated that the means for the data for the five years were different. In those instances where the calculated F-ratio was greater than the critical F-statistic, it is possible to discover which year's data was significantly different from the rest by estimation of the linear contrasts of the column means. This test is a pair-wise comparison of all column means in which the null hypothesis $H_0 : u._i - u._j = 0$ is tested for all possible (i j) pair combinations of the data.

A graphic depiction of the results of these tests for the historic data is included in Appendix D.

The result of this analysis of variance can be summarized by stating that while conditions in an area of interest may be essentially the same from year to year, there are usually some conditions that are significantly different in any one year. For example, the value of distance offshore that SAR incidents occur may be significantly greater for one year. There may be a logical explanation for this phenomena, such as the fish being farther offshore that year, but the analyst probably does not have access to this explanatory information. He can only discover this fact statistically and plan for the recurrence when allocating Coast Guard resources.

The next step in analysing the data for the area of interest is to compare it with the data of all Coast Guard cases nationwide. By comparing the means of the values of sea state, for example, for the area of interest with the means of all Coast Guard cases in any year it is possible to infer whether the seas are rougher than generally experienced nationwide. Similiarly, by comparing the means of severity to persons, it can be inferred that more rapid response is necessary if the mean for the area of interest is greater than for the United States as a whole.

Due to the fact that the weather conditions, the descriptions of vessels in distress, and the positions of distress appear to vary in one single area from one year to the next, an attempt was made to approximate the "average" conditions in the area to use to compare with the nation-wide data. The effects of the variations could be reduced somewhat by pooling the data and using the mean for the five years in the area of interest. This mean was compared with the nation-wide mean for each year's data. The resulting means are shown in the following table. These means also include multi-unit case data in which two or more units reported the same data, but the effect on the validity

of the data was judged to be insignificant because of the relatively small number of such cases.

TABLE OF MEANS OF POOLED DATA
WITH NATION-WIDE DATA

	5YR	1971	1972	1973
	Arcata		Nationwide	
Nature of Distress	7.8583	13.9135	13.1479	12.9107
Distance Offshore	1.4221	1.3629	1.3649	1.3306
Personnel Severity	1.3849	1.1685	1.1677	1.1579
Property Severity	1.3542	1.1394	1.1466	1.1294
Sea State	2.0170	1.3104	1.2811	1.2978
Wind Velocity	1.3815	1.3590	1.3415	1.3545
Visibility	4.5729	4.6738	4.7227	4.6905

A t-test was performed to determine whether the differences between column means could be attributed to chance or to the fact that the means were actually unequal. (The F-test previously used for the analysis of means for the five years would have also been appropriate in this case, but the t-test was used to present an alternative method.) The respective hypotheses which are being tested are:

$$H_0: \bar{x}_{5yr} = \bar{x}_{71}$$

$$H_0: \bar{x}_{5yr} = \bar{x}_{72}$$

$$H_0: \bar{x}_{5yr} = \bar{x}_{73}$$

H_1: The column means are not equal

Since the data represent large random samples of size N_1 and N_2, the sampling distribution of the statistic $\bar{x}_{5yr} - \bar{x}_{7x}$ could be approximated closely by the normal. The common variance, sigma squared, was estimated from the populations and pooled. The statistician realizes that the sample for $\bar{x}_{5yr}$ was not strictly independent from the sample for $\bar{x}_{7x}$ for any year since each contained common observations from the area of interest. However the effect of the approximately 300 observations from the area of interest on the more than 70,000 observations for all the nationwide data for any year was minimal. The t-ratio was calculated from the following formula, where s^2 was the estimated variance:

$$t = \frac{\bar{x}_{5yr} - \bar{x}_{7x}}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

As was the case with the F-test, if the computed value of the t-ratio was greater than the critical t-statistic, the null hypothesis was not This was a two-tailed test in which the means of the data for the area of interest could be either greater than, equal, or less than the means of the nationwide data. The results of the calculations for the area of interest compared with the data for the years 1971 through 1973 are tabulated below:

COMPARISON OF MEANS
POOLED DATA WITH NATION-WIDE DATA

	1971 t-ratio	1972 t-ratio	1973 t-ratio	t-statistic critical
Nature of Distress	11.13	9.74	11.56	1.960
Distance Offshore	2.03	1.92	2.00	1.960
Severity to Personnel	11.39	11.45	11.43	1.960
Severity to Property	10.74	10.35	10.76	1.960
Sea State	14.77	15.39	14.78	1.960
Wind Velocity	0.56	0.99	0.44	1.960
Visibility	1.98	2.94	2.20	1.960

From these results, it was inferred that the means of the values of nature of distress, the severity to persons and property, and the sea state and visibility on scene were significantly different from those of the rest of the United States at the 95 percent confidence level. The differences between the means of degrees of severity, for example, indicate that the danger to persons and property were greater in the Arcata area of interest than the United States as a whole. This hypothesis is supported by a one-tailed t-test at the 95 percent confidence level. The means of the values for sea states and visibilities were also greater.

Having compared the means of the available year-to-year relationships, the next step was to examine the data of each year with the other data of that year. This was done to determine if there was any statistical association among elements of the data. Intuitively, for instance, it could be postulated that the length of the distressed vessel and the distance offshore were associated since small vessels tend to remain closer to shore while larger vessels with better

navigational equipment tend to remain offshore. Similiarly, it could be postulated that there would be a relationship between weather conditions and severity to personnel or property. If such relations were discovered, it might have been possible to hypothesize which factors were independent (not relying upon the occurrence of any of the others) and which were dependent (occurring as a function of some other occurrence). Such independent-dependent relationships would prove very useful in understanding the SAR environment in an area. An indication of the strength of these linear relationships was found by examining the Pearson product-moment coefficient of correlation. As the coefficient of correlation, r, approached the value 1., a strong linear relationship is indicated while the indicated degree of association decreased as r approached zero. A positive value of r indicated that the values of one of a pair of variables increase as the values of the other increase while a negative value indicated the reverse relationship.

The coefficients of correlation for data can be obtained by manual computation or from any of several computer statistical packages. The tables of coefficients of correlation presented in Appendix E were obtained from the SNAP/IEDA Computing Package for the IBM 360 [Ref 14]. These values are for the elements of historical Search and Rescue incidents for the Arcata area of interest for the years 1970 through 1974.

Although useful for indicating relationships warranting further study, the simple coefficients of correlation were not suitable for determining the variation explained by the relationships. To the unwary, the fact that the value of r for one relationship was twice as large as that for another would tend to lead one to believe that the relationship was "twice as strong." This was not necessarily the case. From

the tables of coefficients of correlation it was possible to calculate multiple correlation coefficients for the variables by squaring each value of r. The multiple correlation coefficient, called Mult R, was the maximum correlation between the dependent variable and all independent variables. Its value is represented so:

$$\text{Mult R} = r^2 = \frac{\text{Explained Variation}}{\text{Total Variation}}$$

From the tables of coefficients of correlation for the historic data it was observed that the only consistent binary relationships appear to be between sea state and wind velocity (r varied between 0.46 and 0.86), between severity to persons and severity to property (r varied between 0.23 and 0.63), between distance offshore and sea state (r varied between 0.26 and 0.70), and between distance offshore and wind velocity (r varied between 0.15 and 0.78). The fact that the codes for incidents involving property are centered at the lower numbers while those involving personnel only (personnel injury or involving divers) are at the higher end of the scale was indicated by the positive relationship between nature of distress and severity to personnel and the negative relationship between nature of distress and severity to property. Since consistent binary relationships had not been discovered through the coefficients of correlation, conclusions about which variables were dependent and which were independent could not be made. For the purpose of the thesis, the most critical variables are severity to personnel and to property, because greater severity implies the need for faster response by Coast Guard units. For this reason, the severity to personnel and property variables were assigned structural dependence for the purpose of further analysis.

It is intuitively obvious that none of the independent

elements of a SAR incident such as sea state, distance offshore, or nature of distress act alone on the dependent condition which is severity to personnel or severity to property. A straightforward extension of the association between two variables is the association of several independent variables and the dependent variable. This is termed multiple correlation, and it is also designated by the term Mult R. As in two-way multiple correlations, Mult R is the ratio of the explained variation to the total variation. This multiple correlation coefficient for more than two variables could not be found by simply adding the correlation coefficients found above using only two variables because the interaction of all independent variables acting simultaneously must be taken into account. For this analysis, the values of Mult R were determined using the BIMED02R program from the Biomedical Computer Package [Ref. 2]. (They could be found using manual computations or any of the many statistical packages available.) The strength of the relationships of the variables nature of distress, distance offshore, sea state, wind velocity, visibility, and length of vessel were determined separately for severity to property and severity to personnel for each of the five years data. The results are tabulated below:

MULTIPLE CORRELATION COEFFICIENTS
Severity to Personnel

	1970	1971	1972	1973	1974
Nature of Distress	0.12	0.07	0.04	0.22	0.17
Distance Offshore	0.00	0.00	0.00	0.00	0.02
Sea State	0.04	0.11	0.15	0.01	0.06
Wind Velocity	0.01	0.01	0.03	0.00	0.00
Visibility	0.00	0.00	0.00	0.01	0.00
Length	0.08	0.12	0.02	0.00	0.00
Total Explained Variation (%)	0.25	0.31	0.24	0.25	0.25

MULTIPLE CORRELATION COEFFICIENTS
Severity to Property

	1970	1971	1972	1973	1974
Nature of Distress	0.16	0.02	0.03	0.12	0.12
Distance Offshore	0.02	0.00	0.00	0.02	0.00
Sea State	0.02	0.04	0.02	0.00	0.11
Wind Velocity	0.00	0.00	0.00	0.01	0.00
Visibility	0.00	0.00	0.01	0.00	0.01
Length	0.08	0.37	0.00	0.00	0.00
Total Explained Variation (%)	0.28	0.42	0.07	0.15	0.23

As can be seen, the explained variation of severity to personnel and property was relatively low in all cases. This can be interpreted as indicating that severity to personnel and property were essentially random. Regardless of what the weather conditions, the distance offshore, the length of boat in distress, or even the nature of distress are, the severity to personnel or property was just as likely to be none as it was to be severe in the historic data.

The determination of the simple correlation coefficients, the multiple correlation coefficients for two variables, and the multiple correlation coefficients for all independent variables indicated that the strengths of relationships between the various factors in a SAR incident such as severity, weather, nature of distress, and distance offshore were relatively low (maximum possible is a correlation coefficient of 1.0). This was interpreted as meaning that these states of nature could be simulated as independent events. Their occurrence in any incident could be generated as an event independently from all the rest of the factors. (Independent in the sense that they are separate occurrences.) They did not depend upon any of the other events listed. The truth of this assumption was borne out in the validation of the simulation model when it was ascertained that the distributions of the factors of a SAR incident were the same for simulation-generated data and historic data.

Another data analysis which might prove interesting in the future is the investigation of the relationships between number of boats registered, their lengths, and the number of boats assisted by the Coast Guard. If correlations were found between the number and description of boats registered and documented in an area and the number of Coast Guard cases, it might be possible to derive an equation which would predict the Coast Guard workload given the boat registrations for the current or some prior period. The workload may be a function of lengths of vessels, propulsion, usage, or age. Such a study would require the derivation of a set of regression equations. To conduct such an analysis would require detailed vessel registration data in addition to the Coast Guard SAR data for a particular area, but the benefit may be a consistent, reliable predictor of case loads and the resulting need for Coast Guard facilities.

Another aspect of the historical data was investigated. On the Assistance Report, the reporting Coast Guard unit is required to report the severity to personnel and property. If the severity codes are higher for any given area, it could indicate that more rapid response is necessary. This procedure was described previously. On the Assistance Report, the severity to persons or property is defined and coded as follows[10]

0	None	No personnel/property involved.
1	Small	No immediate or foreseeable danger.
2	Moderate	Some danger that personnel or property might be lost.
3	Severe	Personnel/property was in danger of being lost or was actually lost.
9	Unknown	

For reasons previously described, all cases with code values of nine were sorted out and not used in the data analysis.

In another location on the Assistance Report form, the reporting unit records what may be described as the result of the actions of the Coast Guard. In this section the number of lives saved, number of lives lost, number of persons otherwise assisted, and the value of property assisted are reported.

In an effort to derive a cost-benefit ratio for its SAR program, the Coast Guard has developed a method in which each of these outcomes is assigned a dollar value and used

in a formula to determine an effectiveness ratio. The effectiveness ratio for SAR is value of benefits divided by the sum of the value of benefits and the value of losses. The only losses reported are lives lost. The same figures are used to derive a cost-effectiveness ratio, which is the value of benefits divided by costs of the SAR program.[11]

It is apparent that the adjectives for describing severity are open to subjective interpretation. An analysis was made to determine if the reporting units were consistent in their reporting of degrees of severity. This is, in effect, an evaluation of the quality of the data. The only manner in which this could be done was to compare the number of times which severity to personnel was given as moderate or severe (indicating that outcomes of loss or saving of life might be expected) with the coincidences of reports of actual loss or saving of life.

In the years 1970 through 1974, Coast Guard resources were involved in assisting 2965 persons in the 1468 cases used as the data base. In these cases, 38 persons lost their lives despite Coast Guard efforts in 29 cases. In 56 other cases, 113 persons were reported saved, including one incident in which fourteen lives were reported saved. The greatest number of lives lost in any one case was three. The balance, 2814 persons, were reported assisted in 1200 cases. This data was adjusted for three cases in which some lives were reported helped and some were reported saved, two cases where some lives were lost and the rest of the persons assisted, and one case where one life was saved and one lost. Parenthetically, one hundred cases were coded to indicate only personnel in distress and fifty-six were coded as only property in distress.

The distribution of reported severity to personnel in the five years was:

	None	Small	Moderate	Severe
Number	56	949	305	158
Percent	3.8%	64.6%	20.8%	10.8%

The distribution of reported outcomes of Coast Guard assistance was:

	Lives Lost Cases	Lives Saved Cases	Persons Assisted Cases	No Persons Involved
Number	29	56	1200	183
Percent	2.0%	3.8%	81.7%	12.5%

No reconciliiation was possible between the numbers 183, which indicated no persons assisted, and the number 56, which indicated that no personnel were in distress. The only logical explanation for some of these discrepancies is that a Coast Guard unit was dispatched to assist but aborted the mission before reaching the scene of the incident.

Using this data, it was possible to attempt to determine how many cases reported as having the possibility of loss of life were actually that severe--as reported by the Coast Guard units. The total number of cases where lives were lost (29) plus the number of cases where lives were reported saved (56) divided by the number of cases reported as presenting the greatest severity to personnel (158) would indicate that approximately 54 percent of those incidents reported as being of great severity to persons actually were

so. In other words, rather than 10.8 percent of all the historical cases having a severity state to personnel as severe (code value 3), only about 5.8 percent of the cases were actually that severe. It was interesting to note that of all the cases reported as moderate severity to personnel, in no case was a life actually reported lost or saved. It appeared that persons filling out the Assistance Reports were generous in assigning the degree of severity of the cases they reported and might have been assigning a high severity code in more cases than warranted.

This disparity could be isolated only by close examination of the data reported on the Assistance Reports. In the blocks where severity to property and value of property assisted are reported, no such analysis can be made. Nor is there any method of checking the quality of the figures given for lives saved. The person filling out the Assistance Report must enter the estimated value of the property assisted if no accurate value is known, and there is no way to report the value of property lost. The efficiency ratio is thereby biased and there is no way to verify the figures used to calculate it. This is an area where further study might prove beneficial in order to determine more reliable and realistic measures of performance of the SAR mission.

IV. COMPUTER SIMULATION OF THE ENVIRONMENT

After the data for the area of interest has been examined, the analyst may desire to develop a computer simulation model of the environment within that area. Developing a logical portrayal of the SAR environment for such a simulation is a means of closely studying the relationships of all the pertinent factors in that environment and can lead to a better understanding of the complexities of the environment.

A second use for a simulation model to to generate more data. Only data for five years was available for the Arcata area of interest, and this was deemed insufficient for the purposes of analyzing the need for a new air station.

Another application for such a computer simulation model is to manipulate it in order to test the Coast Guard facilities in an area against differing environments. In the Arcata area of interest, for example, there have been very few incidents reported inland. This is because only water-borne units were stationed in the area and, except for a few isolated cases, the Coast Guard has no means of responding to inland SAR incidents. Analyzing the past data, one could conclude there were no incidents requiring Coast Guard assistance which were not on the water. It is not true that what was not recorded never happened, of course, and the means of inserting such land cases as aircraft crashes, lost hunters, and automobile crashes is presented through a computer simulation model. In another example, if some relationship between number of distress incidents and the number of boats registered in an area were found, future case loads could be simulated by causing more incidents to occur in the computer simulation model.

The purpose of the model for the area of interest, as written for this thesis, was to approximate the environment in which the Coast Guard forces in that area will operate. The parameters of the model were based upon historical data which had been gathered during the course of the normal Search And Rescue operations of the Coast Guard in that area. Once the model was functioning properly and its output was validated against the historic data, it could be used to generate more data to use investigate the need for the Arcata Air Station.

The historic data, as originally received, had to be sorted in order to obtain only those cases which had occurred within the area of interest. The information which was needed to model the environment in the simulation was that pertaining to the weather reported during the distress incidents, the dates and times of the incidents, the types of distress, and the positions of the distress. These items are the elements of a search and rescue incident which occur randomly. All further information reported on the Assistance Report, such as distance to scene of the distress, action taken, and time the assisting resource gets underway or arrives on scene are more-or-less a result of the random factors. As indicated previously, the random elements were also termed "states of nature" in this thesis.

The data which was made available for the model of the Arcata area was for the years 1970 through 1974. Data for the position of distress and the date for the incidents occurring in the years 1970 and 1974 was missing and could not be recovered in time to be used in the thesis. The historic data was sorted and examined statistically to make it usable for the modelling of the environment of the proposed Arcata Air Station. The product of this analysis was a set of cumulative distributions representing the frequencies of the states of nature which had been observed

by the Coast Guard units during search and rescue operations for the years 1970 through 1974. When a model of the environment was constructed, these historic cumulative distributions were relied upon to ensure that the model generated states of nature which corresponded to the historic facts. Since it was proved in the previous chapter that the elements of the SAR environment occurred randomly, the model was designed to generate various elements in any distress incident randomly. Within the computer model, a random number was generated and compared to the historic cumulative distribution of the states of nature. Most computer facilities include a program in their software package which will generate uniformly distributed random numbers. At the Naval Postgraduate School, the program which was used was called RANDOM [Ref. 16]. This program has been statistically proved as being a very good random-number generator and for the purposes of this thesis, the numbers obtained from that program can be assumed to be truly "random." This assumption was supported in tests to be described later.

In order to derive the code value for any element of the environment in the simulation, the computer program first called for a random number. This random number was used in combination with an array stored in the computer which contained the cumulative historic distributions of all the permissible codes for that element. In effect, the array is a table. The random number is compared with all values in the table in order to determine which code value corresponds to the random number. When the program finds the range of values which contains the value of the random number, it determines what the code value is and returns that value to the simulation program to represent the state of nature.

The program for the computer simulation was written in

the FORTRAN IV language. Its scope was limited to model only the environment and to generate SAR cases within the specified area of interest. This meant that actions of the Coast Guard units, such as towing disabled vessels to port or medevacing patients to hospitals, were not modelled because these were outside the scope of this analysis. If the simulation generated a case in which a boat was lost or disoriented at a specified position, the time spent by a Coast Guard unit in searching for that boat was not modelled, although this and other factors could be added to the computer program.

Another factor in the operations of the Coast Guard which was not modelled was the readiness status of the SAR facilities. It was assumed that if an incident occurred, a Coast Guard unit could get underway immediately to respond without recalling the crew or getting ready for sea. This assumption means that when analysing response times for the Coast Guard units, the calculated time to respond is the _minimum_ time to arrive on scene. The computer program used to simulate the environment was included in a later section of this thesis.

The first step of the computer model was to establish the dimensions of the arrays and read into these arrays the historic distributions. Storage arrays were designated which corresponded to the sea state, wind velocity, visibility, latitude, longitude, minutes of latitude and longitude, nature of distress, severity to personnel and property, and time of distress. The data which was read into these arrays was used at various places in the computer program to generate a distress incident.

The main computer program was used to advance the calendar through the model year and to call the subroutines that were required. For the purposes of the simulation, the

Gregorian year was "standardized" in order to eliminate the confusion and difficulties associated with different days of the week falling on different dates in different years. Experience has shown that the incidence of SAR cases is highly cyclical and dependent upon the season, the month, and the day of the week. Each model year consisted of 336 days, or 12 months of 28 days each. The first day of each month was a Sunday, and the same day of the week fell on any given date regardless of the month or the year. The historic day-of-week data of SAR incidents was analysed for the years 1971, 1972, and 1973 and the experience of these three years was converted to the model year. In order to determine the average number of incidents which occurred on the first Sunday of February, for instance, the number of cases reported in the Arcata area for the first Sunday was averaged and assigned to the storage location for February the first in the model year. For the months which have more than 28 days, some of the historic cases were lost because there was no corresponding model date in which to place them. The number of times this happened during the three historic years was so small that the effect of losing these incidents was considered insignificant. In order to increase the total number of cases in the area of interest, the user of the computer simulation could increase the daily average. In a like manner, the workload for any given day could be adjusted.

In order to determine the number of incidents which were to occur on a model day, a subroutine was called by the main program. The number of SAR incidents which have occurred on any day in the past fulfilled the classical Poisson conditions: the number of opportunities for an incident was infinite, the probability of an incident occurring for any given opportunity approached zero, yet incidents happened. The average number which happened on any day is known. The subroutine used the current date and

month to query the array in which the average number of incidents for each day was stored. It used a Poisson distribution to determine the number of cases which were to occur during the current year on that date and returned that number to the main program. If no cases were to occur that day, the main program skipped any further steps, incremented the date by one day, and began the iteration again.

If a SAR incident was to occur on any day, the main program called a subroutine which determined the hours which the incident or incidents were to happen. If more than one incident was scheduled to occur, the subroutine generated a corresponding number of times of day, arranged them into ascending order, and returned the first to the main program to be used as the time of the first incident. The main program controlled the simulation and generated the required number of cases prescribed in the earlier subroutine. As each incident was generated, the main program referred to the time subroutine to obtain the time of the current incident. Each time it was called, the subroutine returned the hours and minutes (clock time) of the current incident.

Having determined that an incident was to occur on any day and the time of that incident, the main program next called a subroutine which determined nature of distress representing the incident and the severity involved. The Coast Guard has responded to virtually every type of distress that can befall man or his possessions, but in the Arcata area relatively few of them occurred during the years 1970 through 1974. It was assumed that this sample was sufficiently representative so that the model would not have to generate types of distress which did not occur during these years. Each of the types of distress which were reported during these years also had a degree of severity to either persons and/or property associated with them. Both the distributions of the types of distress and the

distributions of the degrees of severity to persons and property were stored in an array in the computer model. The subroutine which determined the nature of distress generated a random number, compared it with the cumulative distributions in the nature-of-distress array, and derived the nature of distress for the incident it was in the process of creating. Once the nature of distress was determined, the subroutine could then determine the degree of severity to personnel or property in a similiar manner.

The main program next determined the position of the incident. The historic distribution of SAR incidents was stored in an array in the computer model, but since the overwhelming number of cases had historically been handled by Coast Guard surface units, this distribution was not truly representative of the positions of incidents which would be handled by the Arcata air station. The area of the Pacific Ocean to be serviced by the proposed air station was between 40-00N and 42-00N Latitude and roughly 124-10W and 125-00W. During the years 1971 through 1973 approximately 94.4 percent of the SAR incidents occurred within this area. In the model this area was reduced to a grid, each element of which represented five minutes of latitude (five miles) and five minutes of longitude (approximately 3.7 miles). In the model, each grid was assigned a number representing the historic cumulative distribution of cases which had occurred within its confines in three years. The subroutine which determined the position of distress generated a random number and compared it with the cumulative numbers stored in the grid array in order to determine the latitude and longitude of the distress incident being generated by the main program. If the random number was greater than 94.4, it meant that the incident occurred outside the confines of the 288 grids, or, in other words, that it had either occurred over the land (less than 124-10W) or farther west than 125-00W. If this was the case and the nature of

distress indicated that the incident had occurred on the water (such as vessel disabled, or fire on a vessel), the subroutine generated a Latitude for the distress and a distance offshore greater than 125-00W. An incident in such a location normally could not be handled by the single-engined HH-52 helicopter which would be stationed at the proposed air station. If the seriousness of the situation warranted, a long-range HH-3F helicopter would be flown to Arcata from another air station to perform the mission. If the nature of distress indicated that the incident occurred over the land (such as personnel injury or land vehicle crash) the subroutine generated a bearing and range from the proposed air station to the scene of distress to represent the position of the incident. The bearing and range were generated randomly because of lack of any historic data to indicate the distribution of types and positions of land cases.

The logical result of knowing the position of the distress incident is the determination of the distance to that position from the various Coast Guard facilities in the area of interest. This computation, as well as that which determined the time for a Coast Guard assisting resource to arrive on scene of the distress, was performed by another subroutine which was called by the main program after the position of the incident had been determined. This subroutine was used to determine the minumum response time for a Coast Guard unit to arrive on scene of the generated incident.

The final random state of nature in the environment of a SAR incident is the weather. The weather conditions encountered by the Coast Guard facilities during the prosecution of their search-and-rescue operations were in the five years data. For each incident, the wind velocity, the sea state, and the visibility was reported on the

Assistance Report. The main program called a subroutine which generated these weather conditions according to the historic distributions stored in an array within the model.

Although pertinent to the operations of the Coast Guard, the length of the distressed vessel was not generated because of the implied necessity of analysing position and weather and their combined effects on length. It would be necessary to determine if the historic cases involving smaller vessels tend to center in any specific area and generate lengths that corresponded to these restrictions. For the purpose of this thesis, it was assumed that any of the Coast Guard Cutters in the Arcata area of interest was capable of responding to any of the incidents generated. The purpose of the thesis was to investigate the need for rapid response and not for determining need for towing capability.

Insofar as possible, internal consistency was ensured in the simulation model. If the nature of distress generated was one which normally occurs only over land, a position inland was generated and the sea state code was made to correspond to an inland case. If the nature of distress was vessel aground, the simulation of position was constrained to one adjacent to the coastline. Enforcing such internal consistencies would tend to cause small distortions in the distributions of the environmental elements, but the degree of this distortion could not be discerned.

While it was possible to provide for internal consistencies within any one case, the model is memoryless and consistencies from case to case could not be ensured. This meant that if one case were generated in any position with wind and seas calm, another case could be generated in exactly the same position one hour later with conditions

such as would be experienced in a full gale. Neither the weather from the previous case nor the fact that a Coast Guard unit was very close to the scene of distress was "remembered" in the model. This was considered to be no great problem since, again, the purpose of the simulation was not to model the actions of the Coast Guard units but instead to model the environment. The results of modelling the environment were to be used to generate statistics and not to recreate reality. Output from the simulation program was included in the computer output section of this thesis.

In 1971 the National Bureau of Standards, in a joint effort with the Coast Guard, developed a Search and Rescue Simulation Model (SARSIM) to assist Coast Guard management in planning for its SAR mission [Ref. 7]. The model is highly detailed and quite wide in scope. The model developed for this thesis is in no way meant to replace that resource, but SARSIM was not available to the student for use. As previously stated, one of the purposes of developing a computer simulation model is to gain greater insight into the SAR environment for an area. This insight might not be gained by using SARSIM. It should also be noted that the run time of one year's simulation on the IBM 360/67 at the Naval Postgraduate School is approximately 30 seconds, which translates into an estimated computing cost of about three dollars.

V. VALIDATION OF THE COMPUTER MODEL

The computer model of the environment was not useful until it could be proved that it was generating conditions that represented the actual environment. In order to validate the model it was necessary to check its internal consistency and its agreement with the historic environment of the Arcata area. The first test was relatively simple; the computer output was examined to ensure that such inconsistencies as divers in distress inland or vessels aground ten miles offshore were not being generated.

Testing the consistency of the output of the simulation of the environment from the model with the actual historic environmental conditions required using the same tests that were used in the analysis of the original data. The program for the computer simulation was written so that the distribution of events in the model could never exceed the historic distributions, but it was necessary to test whether the distributions of the output conformed to these historic distributions.

There were two ways in which an inconsistency could occur. First, the process of enforcing internal consistency within a case could alter the resulting distributions of frequencies. The nature of distress, for instance, was generated randomly and the on-scene weather was also generated randomly. In each case, the resulting state of nature was derived by comparing the generated random number with a table of cumulative distributions of historic data. The distribution of simulated events within the model could never exceed the historic distribution if this process were unaltered, since both states were derived independently. When internal consistency was enforced, however, the independent derivation of states was lost. Randomly generating a nature of distress which must have occurred

inland forced a sea state code which indicated a land incident. It also forced an inland position of distress. A large number of such events could alter the resulting distribution of the dependent states such as the position and sea state code.

The second possibility for error in the output of the computer model was an improperly-operating random number generator. As indicated, the states of nature depended upon the generation of a random number which was compared with a table of distributions to derive the correct simulated state. If the random number generater consistently produced a high or low number, the resulting distribution of states of nature would be significantly biased. The only means available to ensure that these errors had not occurred was to statistically compare the data generated by the simulation model with the historic data which had served as the basis for the model.

In order to validate the computer model, three runs representing three years were made using different seed values for the random number generator. The random number generator uses the seed value to compute subsequent numbers. When the random number generator is given the same seed value, it will produce an identical stream of random numbers. Changing the seed value causes the random number generator to compute an entirely new set of numbers. As was done with the historic data, the descriptive statistics of the generated data were obtained. Histograms comparing the pooled historic data and generated data were included in Appendix C. The means of the generated elements of the environment are given in the following table. The means of the five-year pooled data are given because these pooled distributions were used in the model to derive the various states of nature.

TABLE OF MEANS
SIMULATION GENERATED DATA

	Run 1	Run 2	Run 3	5YR Pooled
Nature of Distress	8.3447	11.5581	7.7428	7.8583
Personnel Severity	1.3826	1.5356	1.3333	1.3849
Property Severity	1.4280	1.3521	1.4203	1.3542
Sea State	2.0341	2.1236	2.1051	2.0170
Wind Velocity	1.1667	1.1985	1.2319	1.3815
Visibility	4.4811	4.3970	4.5652	4.5729
Time of Day	12.7273	12.6779	12.1848	12.6679
Month	7.1705	7.0150	6.9855	7.0342

The value for distance offshore is not given because while historically the greatest number of cases (73 percent) occur within three miles of the coastline, this percentage could not be duplicated in the computer model because irregularities in the coastline were not duplicated. Furthermore, the grid size for the generated position of distress was greater than three miles on any side. As a result, the smallest distance offshore which could be generated was more than three miles. Another data element not listed is length of distressed vessel, which was not generated in the simulation.

As was done with the historic data, a one-way analysis of variance was performed comparing each of the runs with the historic data for each of the five years. The hypothesis being tested was:

$$H_0: u._{1,2,3} = u._{70} = u._{71} = u._{72} = u._{73} = u._{74}$$

H_1: The means are not equal

These tests were performed for each element in the table above using the BIMED01V program [Ref 2] which gave an F-ratio as described in the data analysis section. If the F-ratio was greater than the critical F-statistic at least one of the column means was significantly different at the 95 percent confidence level than the rest of the means. The results of the test are tabulated below:

ANALYSIS OF MEANS
SIMULATION-GENERATED DATA

	F-ratio Run 1	F-ratio Run 2	F-ratio Run 3	F-statistic Critical
Nature of Distress	4.08	2.94	2.99	2.21
Personnel Severity	9.49	11.28	10.02	2.21
Property Severity	9.82	9.38	9.85	2.21
Sea State	6.34	6.68	6.58	2.21
Wind Velocity	10.32	10.10	9.73	2.21
Visibility	1.48	1.73	1.39	2.21
Time of Day	4.85	4.68	8.49	2.60
Month	12.43	12.23	12.38	2.60

The result of the tests led to the conclusion that all the means of the simulated data differed significantly from the means of the pooled data. In all the cases where the F-ratio exceeded the critical F-statistic, a pair-wise comparison of column means by estimation of linear contrasts was performed. This was done in order to determine which of the column means were different, resulting in the rejection

of the hypothesis of equality. The graphic depiction of the results of these tests are included in Appendix D.

A summary of the results of these tests is that, except in a few cases, the mean of the generated data did not differ significantly from the means of the historic data. Generally, any time there was a significant difference between simulated-data means and historical-data means, the historical-data mean had been found to be significantly different from all the historical means in the tests performed in the original data analysis. This result tended to validate the presumption that the output of the model conformed to the actual environment.

In order to test the effect of forcing internal consistency within the model and the operation of the random number generator, the data for each run was compared with the pooled data from which it was supposedly derived. For this comparison the t-test was performed. Again, the hypothesis that the row mean for the generated data was not significantly different from the mean of the five-year pooled data was tested at the 95 percent confidence level. A table of the results of that test is presented below:

ANALYSIS OF MEANS
GENERATED DATA VERSUS POOLED DATA

	t-ratio Run 1	t-ratio Run 2	t-ratio Run 3	t-statistic Critical
Nature of Distress	0.35	2.13	0.09	2.015
Personnel Severity	0.04	2.86	1.11	2.015
Property Severity	1.36	0.04	1.28	2.015
Sea State	0.13	0.90	0.74	2.015
Wind Velocity	3.27	2.85	2.14	2.015
Visibility	0.78	1.42	0.07	2.015
Time of Day	0.19	0.03	1.77	2.353
Month	0.81	0.16	0.30	2.353

In most cases the differences between the simulated data and the pooled five-year actual data are not significant at the 95 percent confidence level. In some instances the t-ratio was greater than the critical t-statistic, which indicated that the differences were significant. This can be expected to occur one time in twenty by the construction of the test. As long as it does not recur consistently, it was not considered significant, since this would occur with any data.

In the case of wind velocity, however, the differences were consistently greater than expected. In each of the three simulation runs, the mean of the wind velocities was significantly lower than the mean of the five-year pooled data. The explanation for these differences was found when examining the distributions of the historic data. The permissible code values for reporting the wind range from the value zero to nine. The value nine is used to indicate unknown conditions. This value appeared three percent of the time in the historic data, but was not permitted to

appear in the simulated data. When the nines were removed from the historic data the new mean became 1.1571 instead of 1.3815, and when this mean was tested against the simulation runs there was no significant difference between them. It appeared that the inclusion of the value nine weighted the mean sufficiently in the historic data to cause a significant difference when compared with a vector of wind velocity values where the value nine was not present. Even if all the historic observations had been a higher-than-normal code value, such as six, the differences between historic and simulated data would not have been significant. The code value of nine is permissible for the other weather conditions, but the number of times it occurred was not sufficient to cause a significant difference between the historic data means and the those of the simulated data.

An important comparison of data was that pertaining to nature of distress. The code values of nature of distress range between 00 and 99, but not all numbers are used to describe a nature of distress. In the case of the Arcata area of interest, several of the permissible values were never used in the data for five years. It was important that the distributions of the simulated nature of distress reflect the actual distributions, and this coincidence had to be tested. The distribution of data for nature of distress is given in the table below:

DISTRIBUTION OF NATURE OF DISTRESS
(Figures in Percent)

Nature of Distress	Historical Distribution	Simulated Distribution
Other Vessel Conditions	3.5	4.2
Vessel Disabled or Adrift	56.3	58.0
Vessel Disabled and Anchored	6.1	4.8
Vessel Aground	3.6	3.6
Vessel Capsized or Sinking	4.4	3.6
Vessel Fire or Explosion	1.6	1.0
Vessel Flooding or Sinking	6.1	7.0
Vessel Overdue/Missing	5.7	4.5
Vessel Collision	0.4	0.1
Vessel Disoriented-Lost	3.2	2.6
Vessel Endangered by Weather	0.5	0.4
Aircraft Distress	0.8	0.9
Land Vehicle Distress	0.2	0.0
Land Structure	0.3	0.4
Diver in Distress	0.4	0.7
Personnel Medevac	0.7	0.9
Person Drowning	0.4	0.6
Person in Water	0.8	1.3
personnel Sickness	2.6	2.5
Personnel Injury	1.2	1.6
Person Lost on Land	0.3	0.3
Other Miscellaneous Conditions	0.3	0.3
Flare Sighting	0.6	0.7

The appropriate statistic used to determine if these distributions were equal was the chi-square goodness-of-fit test. The chi^2 statistic is given as follows:

$$\text{Chi}^2 = \sum \frac{(\text{observed frequency} - \text{expected frequency})^2}{\text{expected frequency}}$$

In this equation, expected frequency was the historic frequency and observed frequency was the simulated frequency for each of the nature-of-distress codes. The value of the ratio was found for each of the entries in the nature-of-distriss distribution table and summed to find the chi-squared statistic. This statistic was computed as 2.68; the critical chi-square statistic with 22 degrees of freedom at the 95 percent confidence level is 12.34. It was concluded that there was no significant difference between the two distributions of nature of distress. Similiar chi-squared tests were performed on all elements of the data to compare the goodness of fit between historic data and simulated data distributions with the same results.

The conclusion reached as a result of all these tests comparing the historic data and the data generated by the computer model of the environment was that the simulation data was not significantly different from the historic data. It was concluded that the data generated by the simulation could be used to augment the historic data and, within limits, could be used to represent the environment in the area of interest.

VI. ANALYSIS OF ALTERNATIVES

After historic data had been analysed and more data had been generated using the computer model, the data which was available was used to determine the effectiveness of alternate methods of providing SAR coverage for the Arcata area of interest. One of the alternatives was the proposed air station at Arcata. A computer program was written which performed this step.

The computer program was written to compute times required for various Coast Guard units to arrive on the scene of distress from their "home" positions. This time is termed response time. The response times were calculated for surface units at Humbolt Bay and Crescent City, for HH-52A helicopters from San Francisco, for HH-52A response from the proposed air station at Arcata, and for HH-3F helicopter response from San Francisco. The first three facilities are currently serving the area of interest, and the latter two were alternate options for SAR air coverage in the Arcata area. The computer program calculated only transit times for Coast Guard units from their base to the scene of distress at assumed speeds. The response times did not include total time between alerting the SAR facility to the time to either launch the unit or get it underway. The response time did include some "dead time" in calculating response of aircraft transiting between air stations other than Arcata and the Arcata airport. These delays were added to account for reasonable ferry times, for refueling times, and for other logistics delays.

The speed of advance for surface vessels was set at eighteen knots in all cases. It was assumed that the unit would always travel at this speed regardless of weather. It was also assumed that any surface unit could respond to any

SAR incident anywhere in the area of interest. In actuality, of course, the choice of the appropriate surface unit would be a function of weather, distance to scene, distance offshore, nature of distress, and alert status of the unit at the time of distress.

The transit time for an HH-52A helicopter from San Francisco Air Station to Arcata was assumed to be 2.7 hours for the 210 miles. Once the helicopter arrived in Arcata, it was assumed that one hour would be required to refuel the helicopter before it could be launched for the SAR mission. The transit time for HH-3F helicopters from San Francisco to Arcata was assumed to be 1.75 hours. If the incident occurred less than 100 miles from the coastline, the helicopter was assumed to be capable of flying directly to scene from San Francisco without refuelling. The speed over ground for HH-52A helicopters was assumed to be 85 knots despite wind conditions. The speed used for HH-3F helicopters was 120 knots.

HH-52A helicopters from Arcata and San Francisco were assumed to be permitted to fly 25 miles offshore unescorted. If the straight-line distance from the Arcata airport to the scene of distress was greater than 25 miles but the scene could be reached by flying parallel to the coast to the correct latitude and then perpendicular to the coastline to the scene of distress, this two-leg distance was computed. For distress positions between 25 and 100 miles offshore, an HH-52A helicopter could conduct the mission only if escorted by a fixed-wing aircraft. It was assumed that 1.5 hours were required to fly a fixed-wing aircraft from San Francisco to Arcata before the helicopter could begin the mission.

For positions of distress greater than 100 miles and less than 300 miles offshore, an HH-3F helicopter was

required to effect the rescue. It was assumed that six hours were required to fly the helicopter to Arcata, refuel it, man it with a fresh crew, and launch it for the mission. This time was not required if the helicopter were stationed in San Francisco.

The computer program which calculated response times for Coast Guard units used the positions of distress which were generated in the computer simulation. A modification of this program calculated response times using data from three years historic incidents. As was expected, the average response time varied from year to year because the positions of distress varied. Besides using the three years historic data, seven years simulated data was used to determine response times, yielding the equivalent of ten years activity. The assumption was made that the distribution of the positions of distress would not change. It was also assumed that the distributions of the percentages of the severity to personnel and property codes did not change. A sample output from the computer program was included in the Computer Output section.

Without an air station at Arcata, California, the calculated average response time for all over-water incidents was 0.66 hours, or about 40 minutes. With an air station at Arcata, the average response time was 0.56 hours, or about 34 minutes. With HH-3F helicopters at San Francisco, the average response time for the over-water cases was the same as that with no air station at Arcata, or 0.66 hours. This was so because in almost every case a surface unit arrived on scene in less time than it took for the HH-3F to fly from San Francisco to Arcata. The few cases in which this was not true were those cases occurring greater than approximately forty miles offshore, where the response time for air and surface facilities was equal. Historically, SAR incidents have occurred more than 50 miles

offshore in the area of interest less than ten percent of the time.

The effectiveness of the proposed air station can not be measured as a reduction in average response time to all incidents, since a helicopter would be used only in moderate or severe cases. Moderate and severe cases historically occurred about thirty percent of the time. The average response time to moderate-severity cases without Arcata Air Station was 0.7 hour (about 42 minutes). The range for that average was from 0.48 hour to 0.91 hour in different years. The average response time with Arcata Air Station established was 0.42 hour (about 25 minutes). The range of yearly means was from 0.30 hour to 0.55 hour. It was assumed that a helicopter would not launch from San Francisco on a moderate-severity case.

The cases with the greatest severity to persons or property reported averaged about ten percent in the historic data. The average response time to these cases without an air station at Arcata (but with helicopter assistance from San Francisco) was 0.75 hour (about 45 minutes). The yearly averages ranged between 0.58 hour and one hour. The average response time with an air station at Arcata was 0.42 hour (about 25 minutes). This yearly average ranged between 0.25 hour and 0.74 hour. The average response time with HH-3F helicopters at San Francisco was just slightly less than the average with HH-52A helicopters at San Francisco.

The average response time to both moderate or severe cases without Arcata Air Station and with either HH-52As or HH-3Fs at San Francisco was 0.72 hour (about 43 minutes). With an air station at Arcata, the average response time was 0.41 hour (about 25 minutes).

In addition to making these absolute determinations of

effectiveness, it was necessary to compare the effect of the additional air station relative to the "acceptable SAR response time" as set forth in the Aviation Plan. The tables below show the percentage of times the response times of the Coast Guard units were greater than the Aviation Plan standard. The tables include both historic data computations and simulated data computations.

PERCENTAGE OF RESPONSE TIMES
GREATER THAN ONE-HALF HOUR

	1971	1972	1973	Run1	Run2	Run3
Without Arcata Air Sta.	0.50	0.68	0.57	0.58	0.61	0.60
With Arcata Air Sta.	0.17	0.56	0.45	0.36	0.40	0.41
Acceptable	0.25	0.25	0.25	0.25	0.25	0.25

PERCENTAGE OF RESPONSE TIMES
GREATER THAN ONE HOUR

	1971	1972	1973	Run1	Run2	Run3
Without Arcata Air Sta.	0.12	0.12	0.30	0.16	0.18	0.20
With Arcata Air Sta.	0.08	0.10	0.22	0.08	0.11	0.12
Acceptable	0.10	0.10	0.10	0.10	0.10	0.10

The "acceptable response time" is not more than 25% of cases requiring one-half hour and not more than 10% requiring one hour. The addition of a Coast Guard air station at Arcata does not permit the Coast Guard to meet the established standard in all incidents, but it does permit them to reach the standard a greater number of times.

A much more favorable case was made for an air station at Arcata if the incidents occurring over land were considered. In these incidents, the transit time for a

helicopter from San Francisco to Arcata was saved: 1.75 hours for an HH-3F and 2.7 hours for an HH-52A. Undoubtedly, the number of Coast Guard responses to land incidents would increase if an air station was established at Arcata, but there was no means of analyzing the effectiveness of the air station relative to the SAR facilities presently serving the area. Whether this supplement to present over-land resources justifies the establishment of a new air station or not is a policy decision.

VII. CONCLUSIONS

Since there was no established relationship between lives lost or saved and response time when this thesis was written, the results of this study must be stated merely as information for the decision maker. An air station at Arcata, California will probably reduce Coast Guard response time to SAR incidents involving moderate and severe danger to persons and property in the area of interest an average of fifteen to twenty-five minutes. It will reduce the percentage of times which Coast Guard units, other than fixed-wing aircraft, cannot arrive on scene of a distress which is up to 150 miles offshore within one-half hour from approximately sixty percent to approximately forty percent of the time. Its presence will reduce the percentage of times that response time in this zone is greater than one hour from approximately twenty percent to approximately ten percent. These numbers are based on case loads of approximately 250 to 350 per year in the Arcata area. Of these cases, approximately 75 to 105 cases are of moderate or severe severity. These figures do not account for the possible delay in response by aircraft caused by low ceilings or low visibilities at the Arcata Airport.

APPENDIX A

☐☐☐☐ TYPEWRITER ALIGNMENT

RCS OSR-2000

PAGE ☐ OF ☐

DEPARTMENT OF
TRANSPORTATION
U. S. COAST GUARD
CG-3272 Rev. 3-69)

ASSISTANCE REPORT

REPORTING UNIT

UNIT CASE OF

NAME OF DISTRESSED UNIT

OWNER (Name, address, zip code)

A. IDENTIFICATION DATA

01	02	OPFAC
02	09	Multi-Unit Case Number
03	13	Unit Case Number
04	17	Month and Year Notified
05	20	Total Number of Sorties on Case

B. CASE DATA

01	22	Date/Time Notified
02	28	* Time From Occurrence to Notification
03	30	Means of Initial CG Notification
04	32	Nature of Distress
05	34	Distance Offshore
06	35	N Latitude
07	39	W Longitude
08	44	Method of Locating Distress
09	45	Severity — Personnel
10	46	Severity — Property
11	47	Cause of Distress
12	48	Sea State
13	49	Wind
14	50	Visibility
15	51	Type
16	52	Owner
17	53	Usage
18	55	Propulsion
19	57	Length
20	58	Gross Tonnage
21	59	Off/Reg No.
22	68	Number of Lives Lost
23	70	Number of Lives Saved
24	72	No. of Persons Otherwise Assisted
25	75	0 0 0 0 VAL-PPTY Assisted

Items 15–20: DESCRIPTION OF DISTRESSED UNIT OR UNIT ASSOCIATED WITH PERSONNEL IN DISTRESS

NATURE OF DISTRESS		
SEVERITY	PERSONNEL	
	PROPERTY	

EXPLAIN "OTHER" CODES. ADD ANY CLARIFYING INFORMATION, STATE ANY UNUSUAL OCCURRENCES

C. SORTIE DATA

01	20	Type of Assisting Resource
02	22	Assisting Resource No.
03	28	Date/Time Underway
04	34	☐ Number of Resources Remaining on Stand-by
05	35	Date/Time on Scene
06	41	Distance to Scene or Search Area
07	42	* Total Time nn Sortie
08	45	Assistance Rendered to Personnel
09	47	Assistance Rendered to Property
10	49	Performance Index — Use Comments

C. SORTIE DATA

01	20	Type nf Assisting Resource
02	22	Assisting Resource No.
03	28	Date/Time Underway
04	34	Number of Resources Remaining on Stand-by
05	35	Date/Tune nn Scene
06	41	Distance to Scene or Search Area
07	42	* Total Time nn Sortie
08	45	Assistance Rendered to Personnel
09	47	Assistance Rendered to Property
10	49	Performance Index — Use Comments

COMMAND LEVEL	INITIALS	SIGNATURE	DATE
UNIT			
GROUP			
DISTRICT			

* THIS DIGIT REPRESENTS TENTHS OF HOURS

PREVIOUS EDITIONS ARE OBSOLETE

WHITE – COMMANDANT (OSR)

APPENDIX B

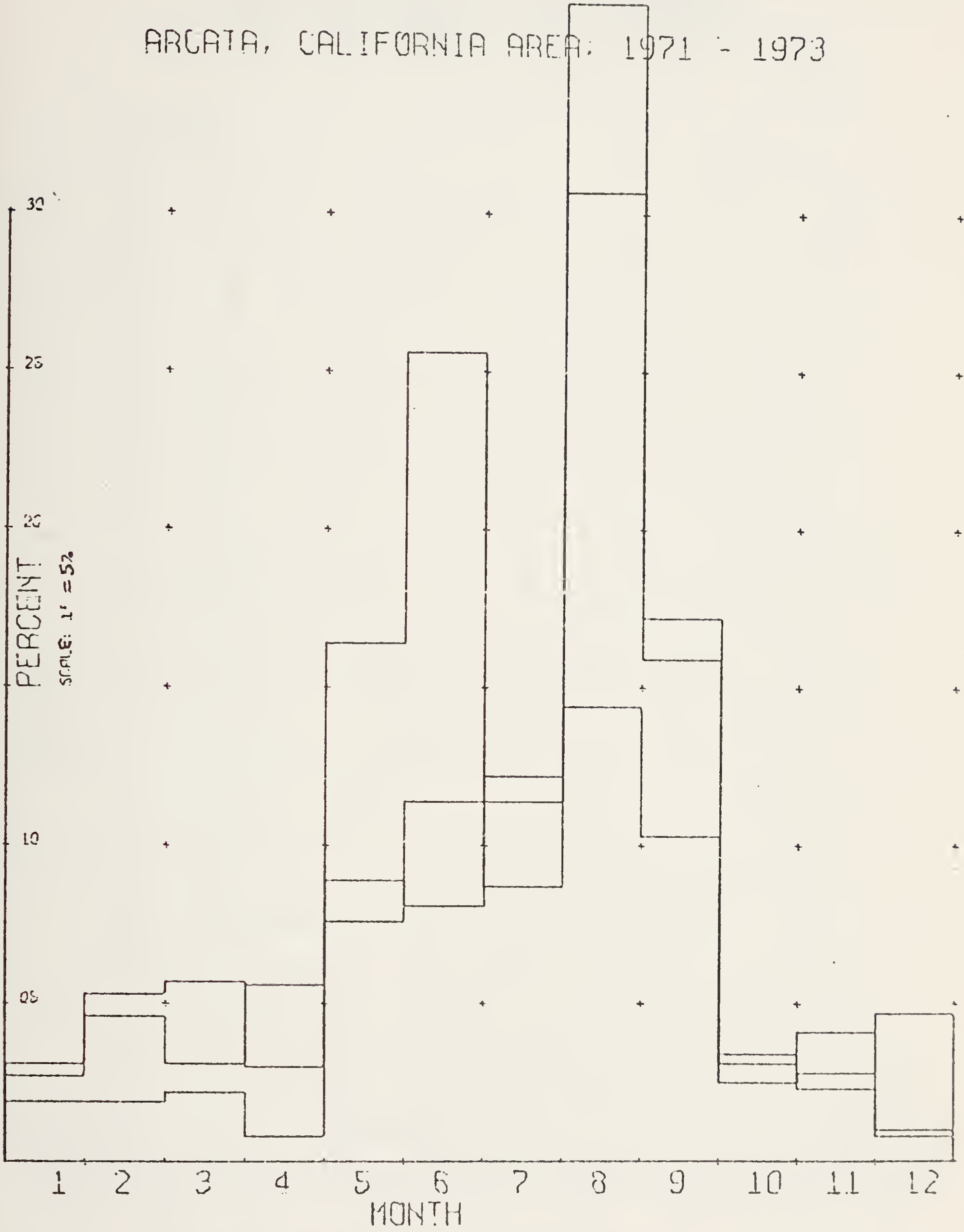
Histograms of Five-Year Data in Arcata Area of Interest

The following seven histograms are the distributions of the code values reported in the historic data for the Arcata area of interest. Each graph is, in effect, five separate histograms superimposed upon each other. Rather than showing the distributions of the code values for any specific year, the graphs are intended to show the general distributions experienced in the area of interest as reported in the Assistance Reports. These distributions were pooled, or averaged, to give the cumulative distributions used in the data analysis and the computer simulation model. A table of code values depicted in this appendix can be found in Appendix G. These histograms were drawn using the CALCOMP Model 765 and the plotting package [Ref. 15] at the Naval Postgraduate School.

HISTORICAL SAR INCIDENTS

MONTHLY FREQUENCY DISTRIBUTIONS

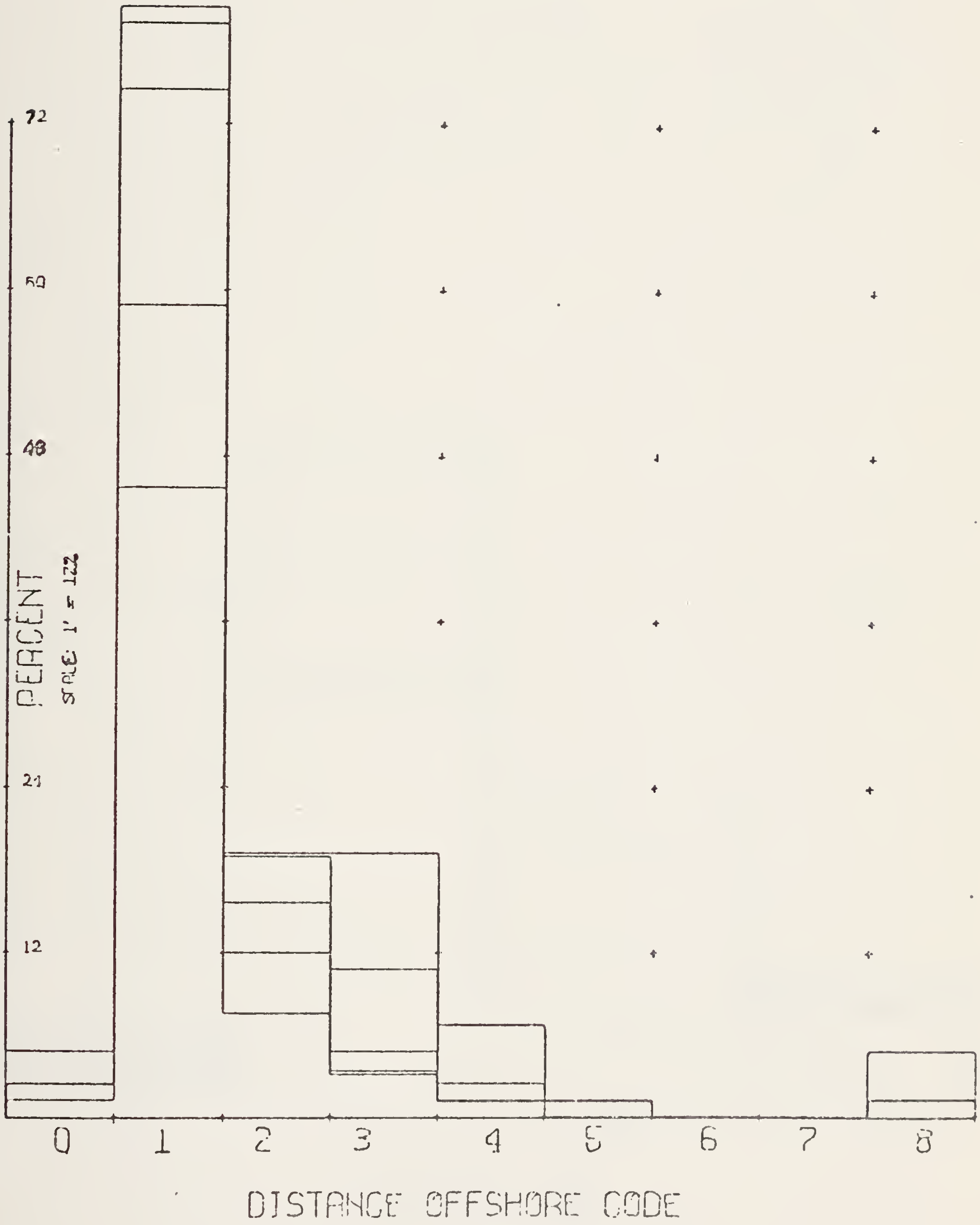
ARCATA, CALIFORNIA AREA: 1971 - 1973



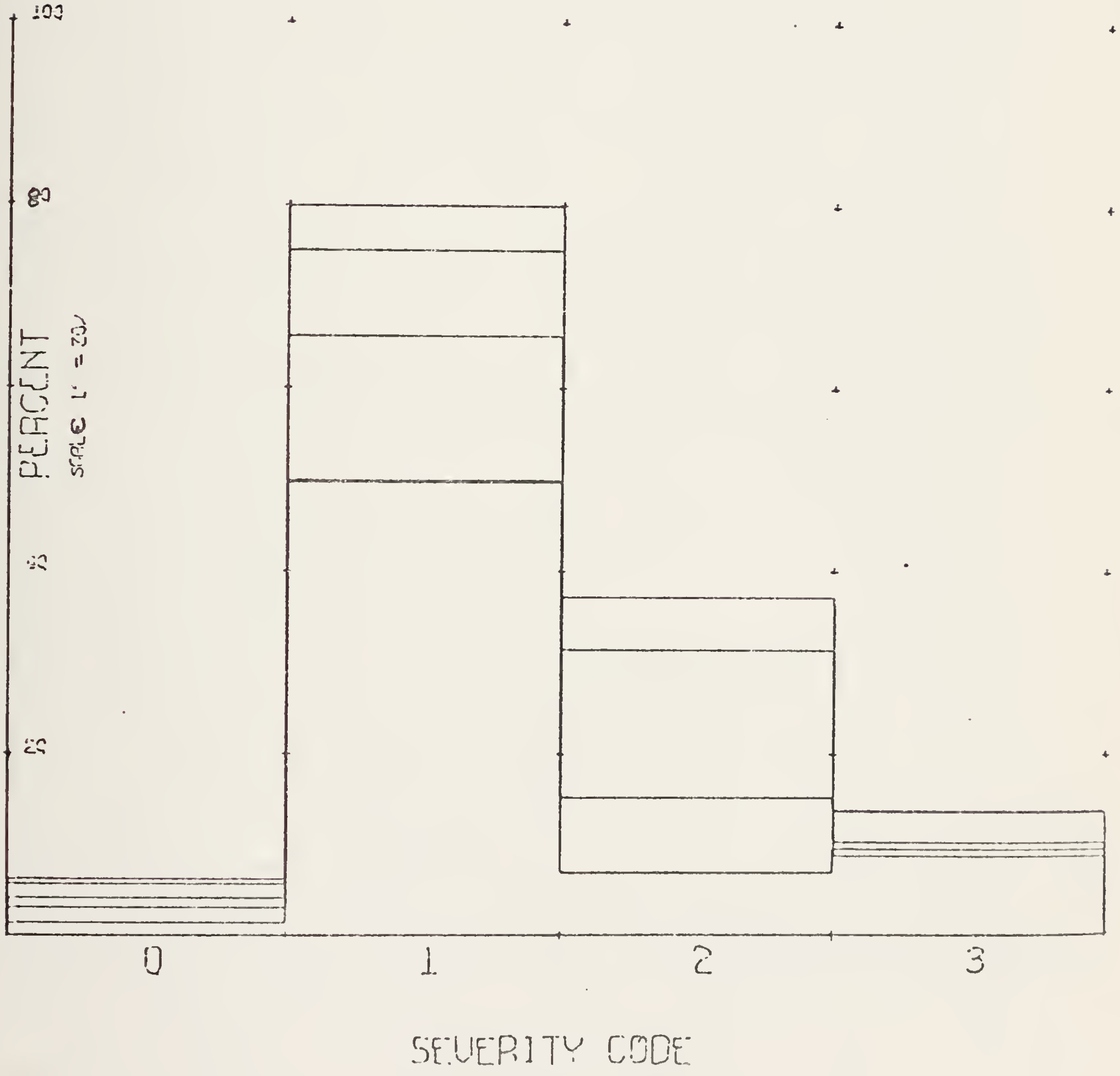
HISTORICAL SAR INCIDENTS

DISTANCE OFFSHORE

CODE FREQUENCY DISTRIBUTIONS
ARCATA, CALIFORNIA AREA, 1970 - 1974



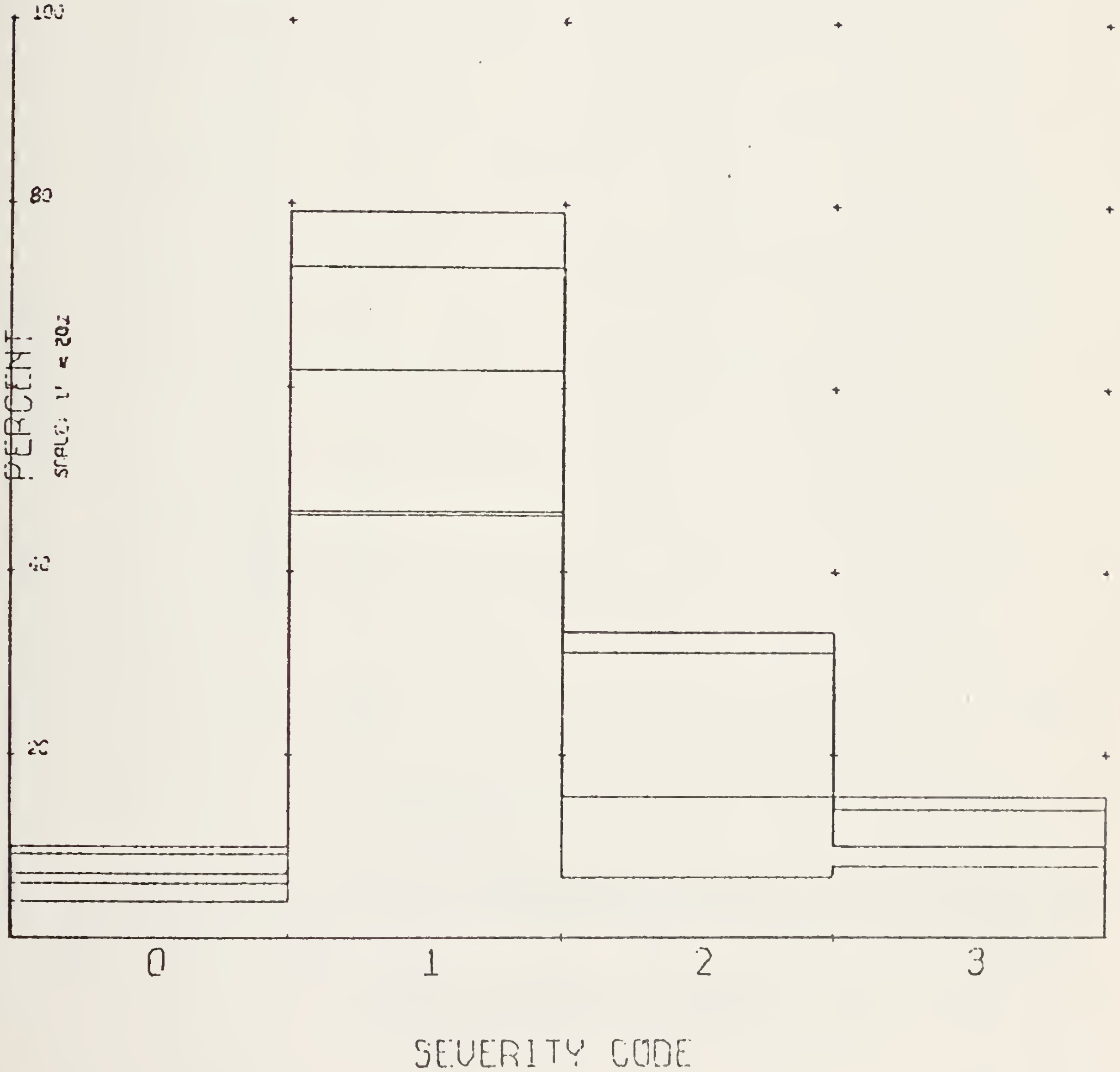
HISTORICAL SAR INCIDENTS
SEVERITY TO PERSONS
CODE FREQUENCY DISTRIBUTIONS
ARCATA, CALIFORNIA AREA, 1970 - 1974



SEVERITY TO PROPERTY

CODE FREQUENCY DISTRIBUTIONS

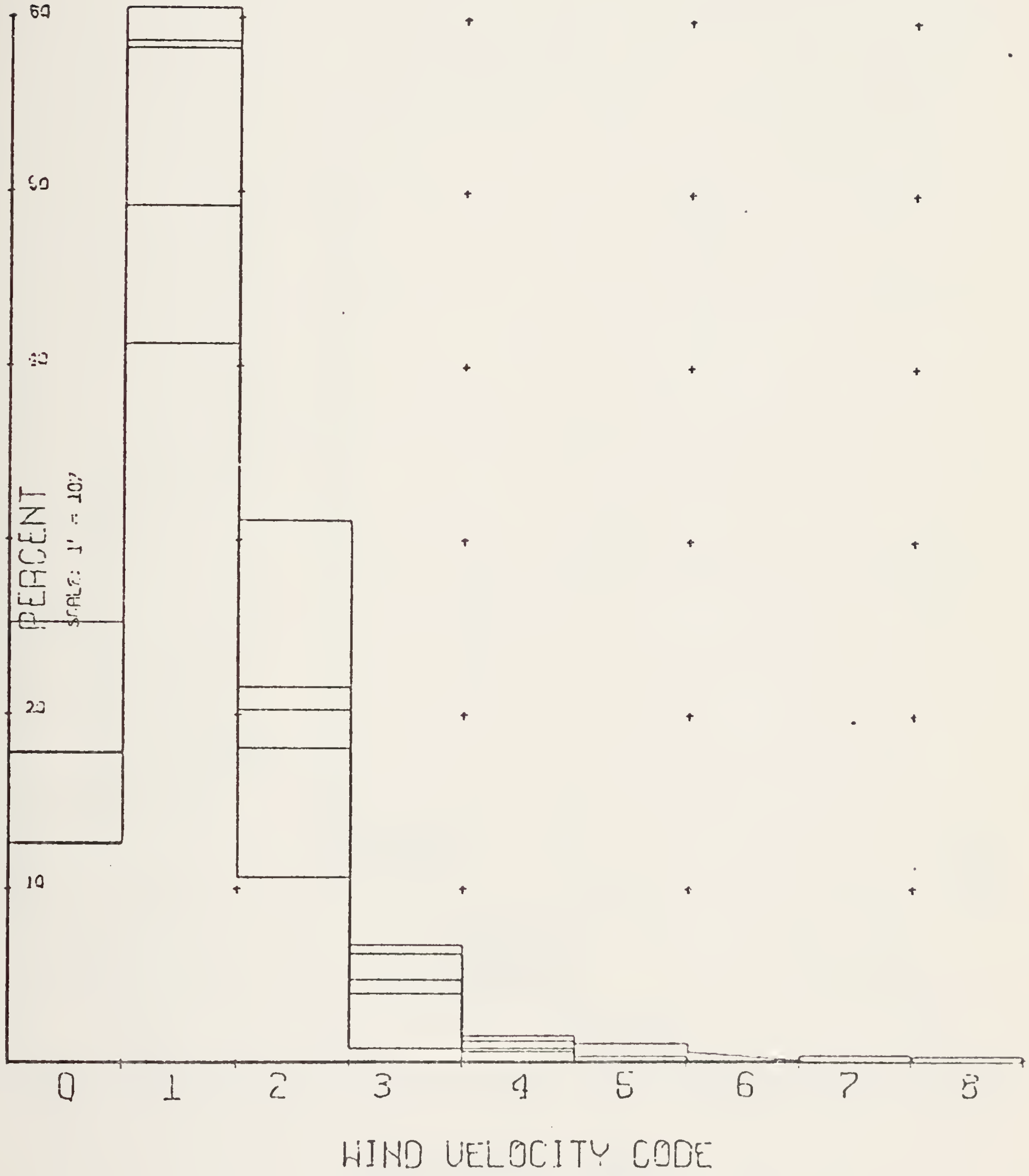
ARCATA, CALIFORNIA AREA, 1970 - 1974



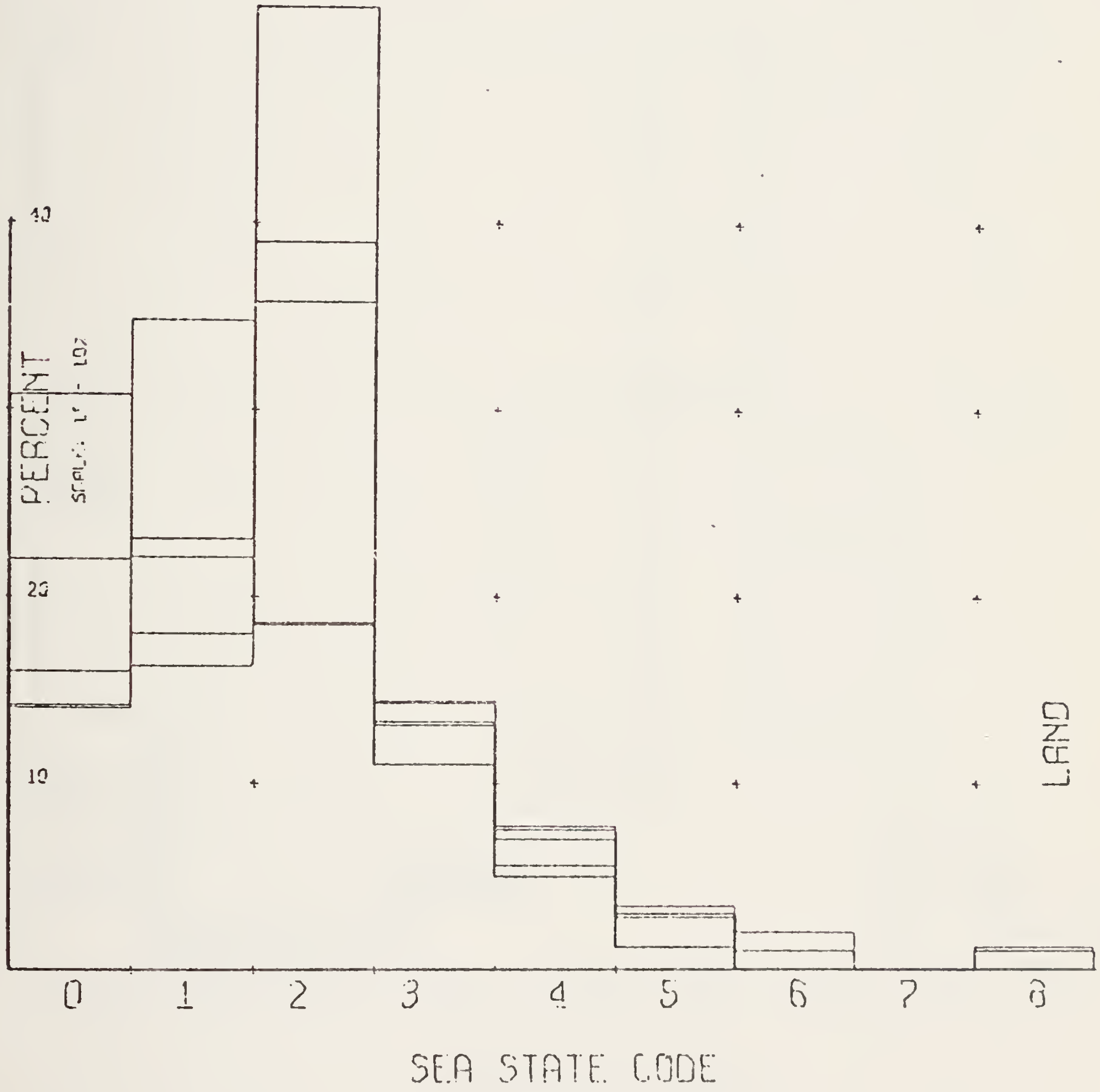
HISTORICAL SAR INCIDENTS

WIND VELOCITY

CODE FREQUENCY DISTRIBUTIONS
ARCATA, CALIFORNIA AREA; 1970 - 1974



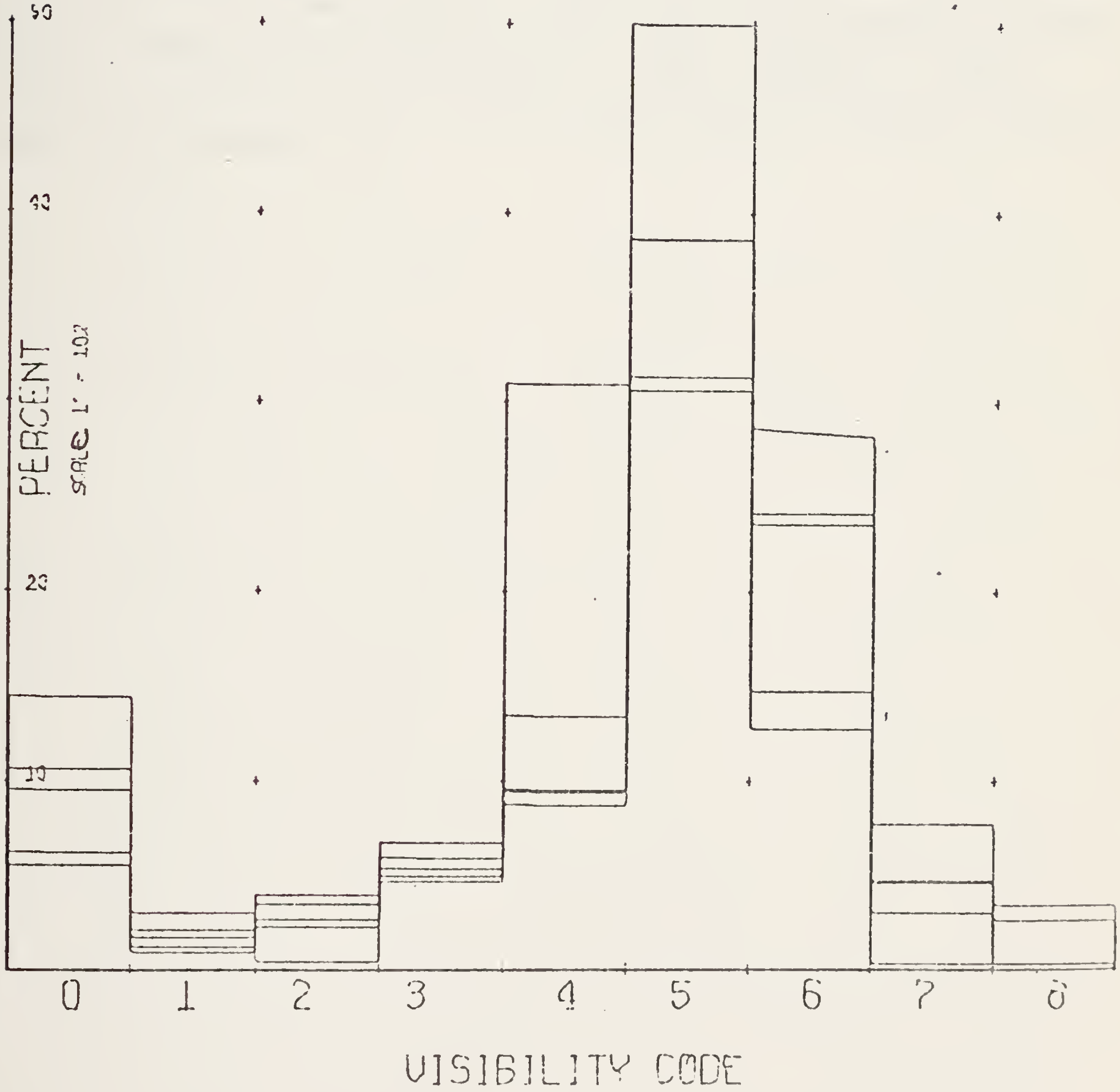
HISTORICAL SAR INCIDENTS
SEA STATE
CODE FREQUENCY DISTRIBUTIONS
ARCATA, CALIFORNIA AREA, 1970 - 1974



HISTORICAL SAR INCIDENTS

VISIBILITY

CODE FREQUENCY DISTRIBUTIONS
ARCATA, CALIFORNIA AREA: 1970 - 1974

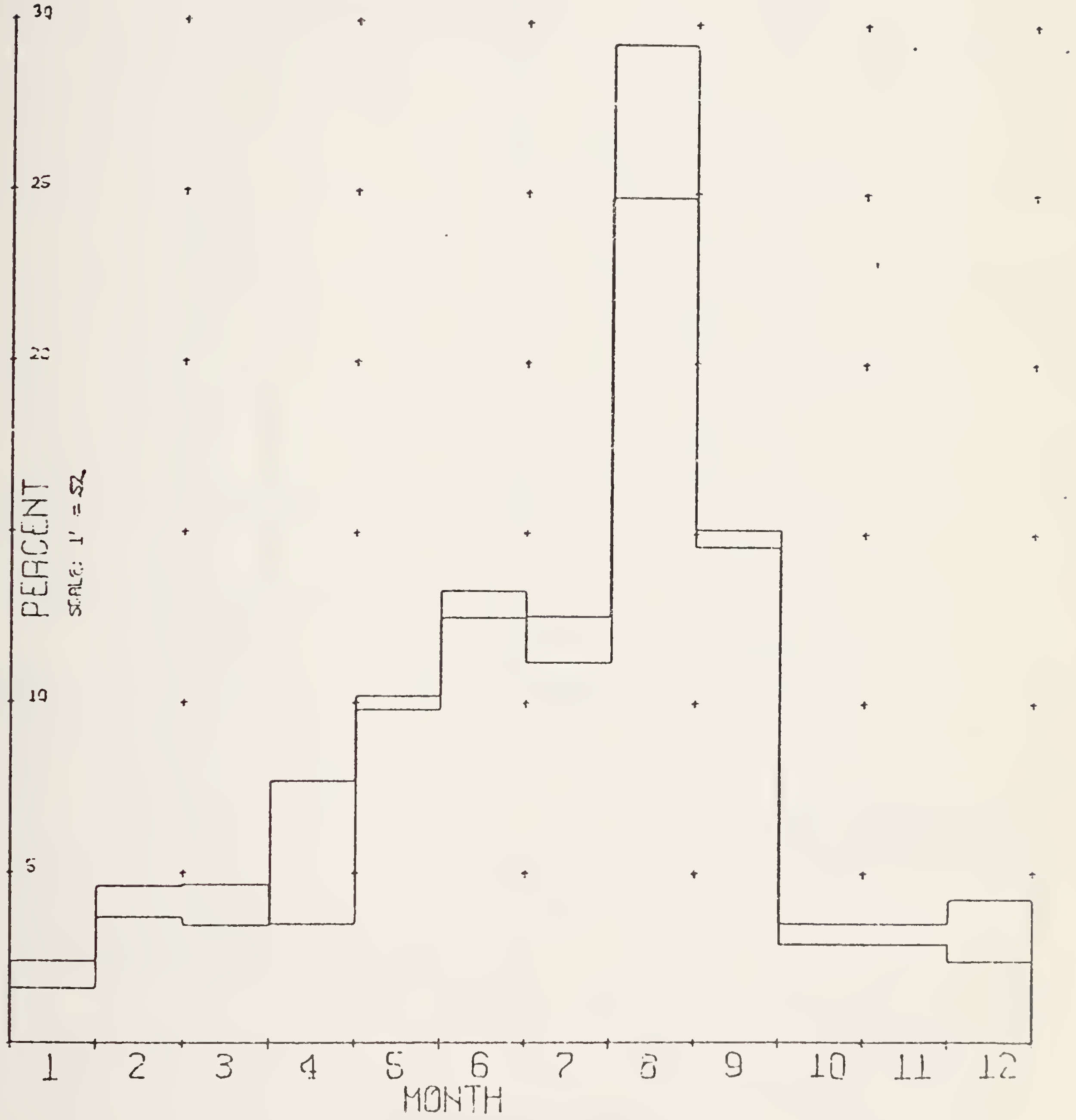


APPENDIX C

Histograms of Pooled Data and Simulation-Generated Data

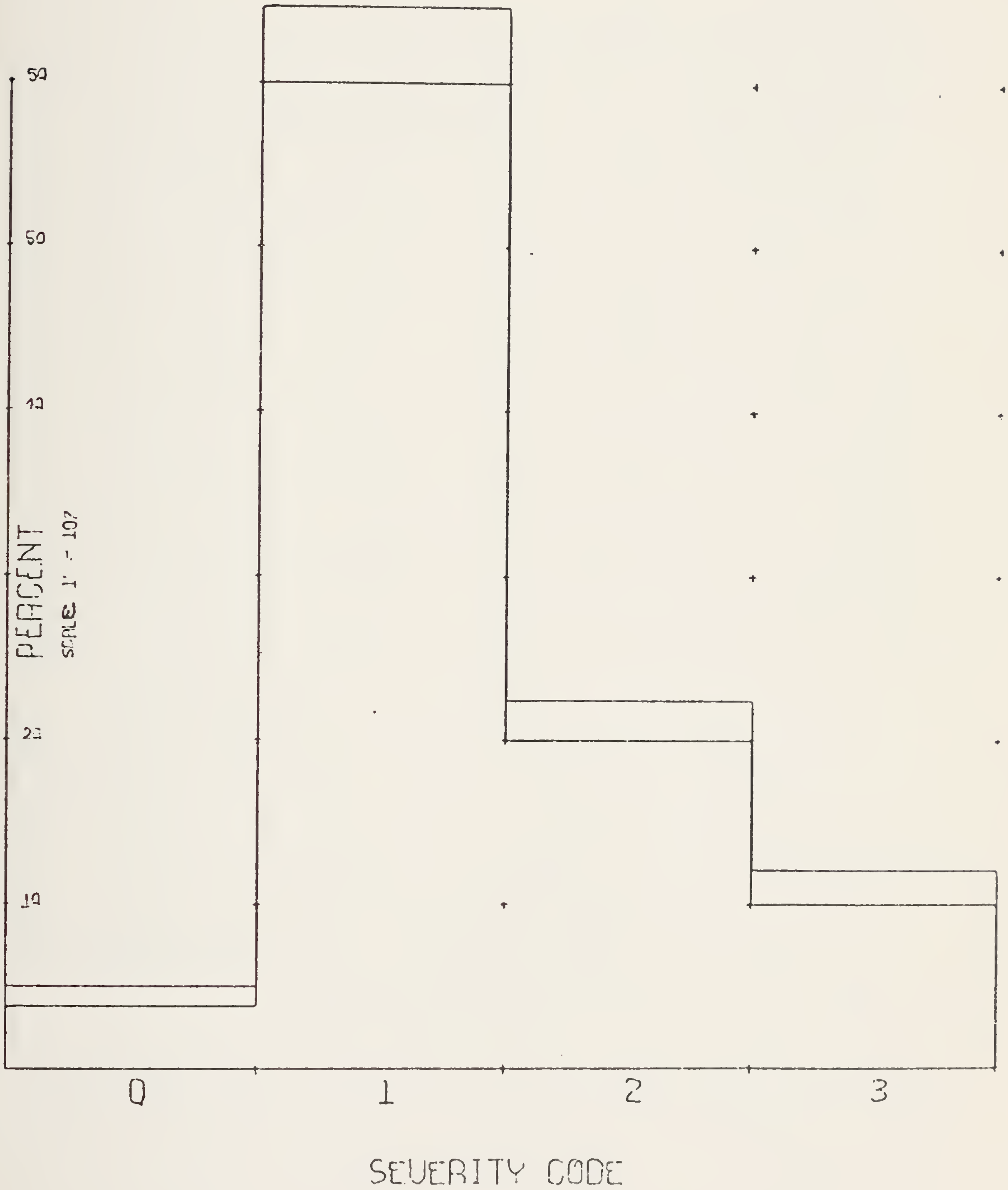
The following six histograms were included to show the pooled distribution of code values for the five years historic data in the Coast Guard records and the distribution of the pooled data from three simulation runs. The hypothesis that these distributions were equal was accepted in an analysis-of-means test in the chapter of the thesis dealing with validation of the computer model. A table of code values depicted on these histograms can be found in Appendix G.

MONTH
CODE FREQUENCY DISTRIBUTIONS
HISTORICAL DATA 1970 - 1974
SIMULATION GENERATED DATA



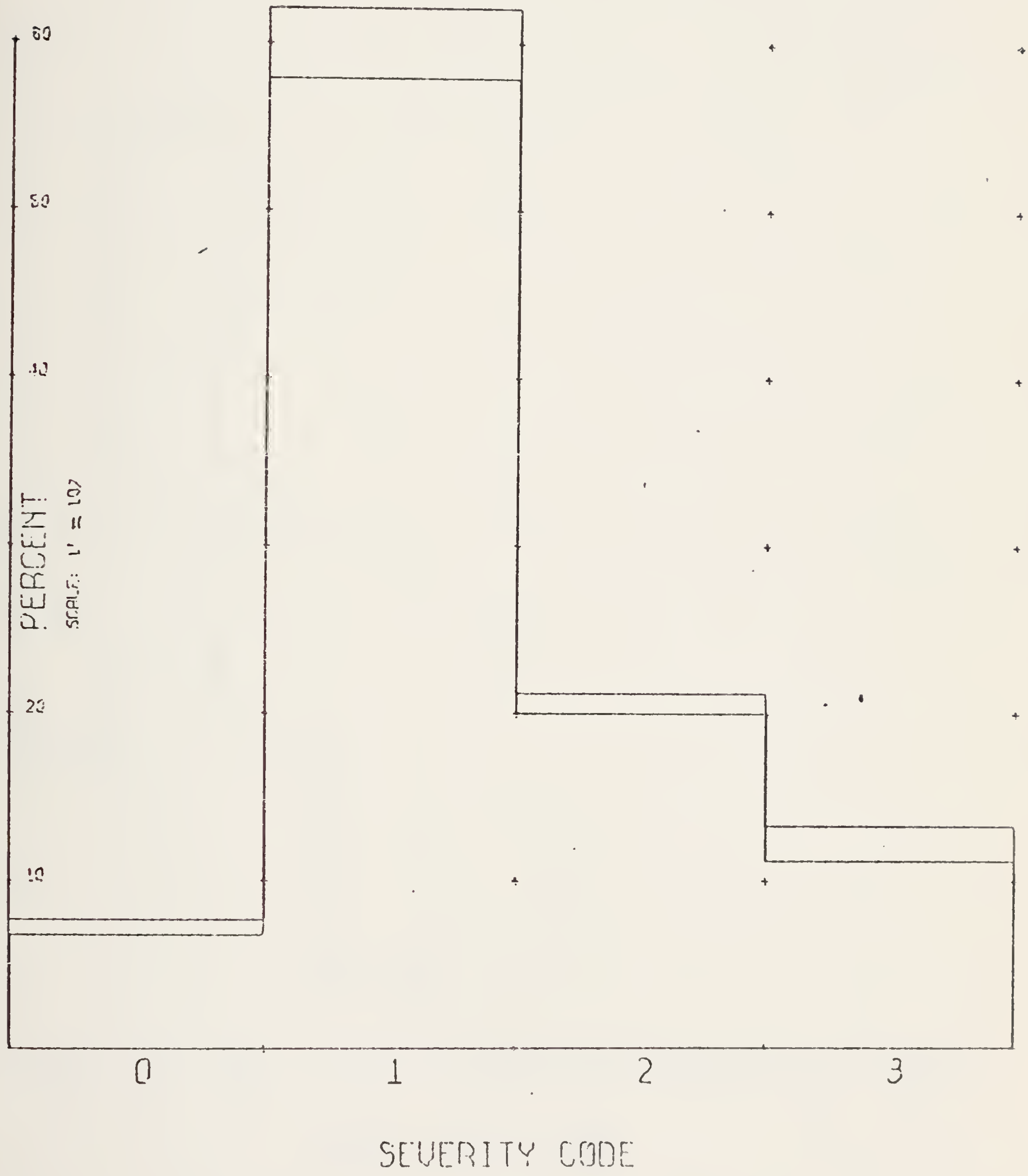
SEVERITY TO PERSONNEL

CODE FREQUENCY DISTRIBUTIONS
HISTORICAL DATA 1970 - 1974
SIMULATION GENERATED DATA



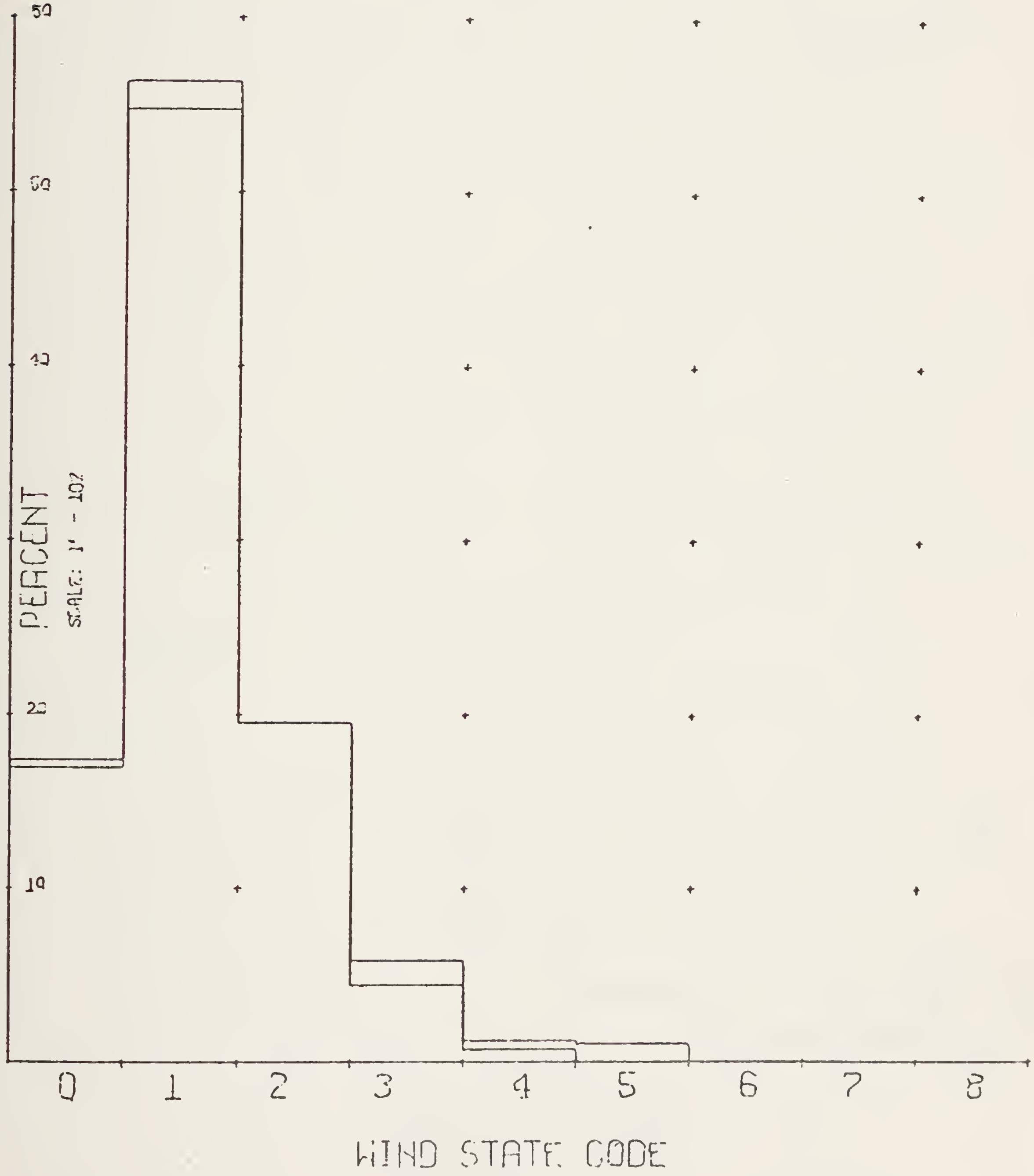
SEVERITY TO PROPERTY

CODE FREQUENCY DISTRIBUTIONS
HISTORICAL DATA 1970 - 1974
SIMULATION GENERATED DATA



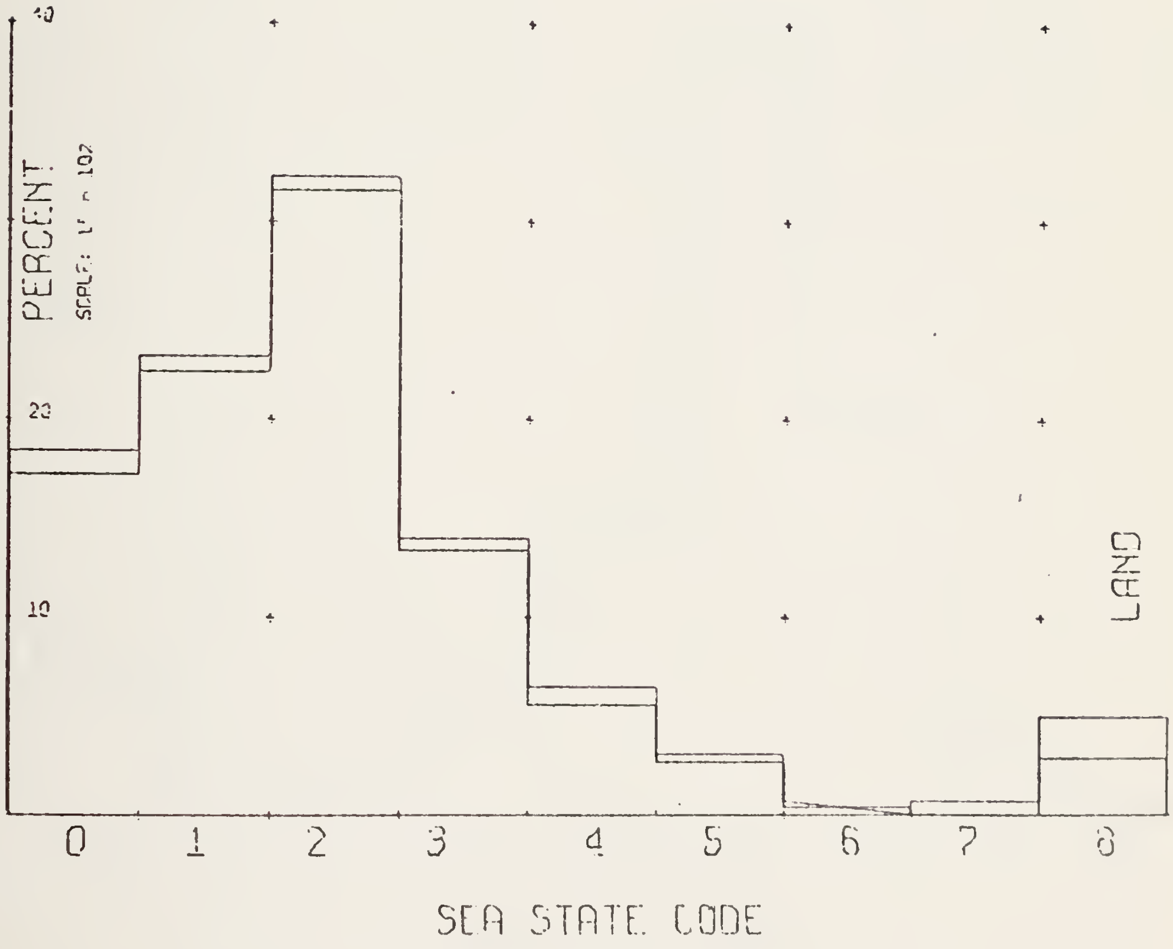
WIND VELOCITY

CODE FREQUENCY DISTRIBUTIONS
HISTORICAL DATA 1970 - 1974
SIMULATION GENERATED DATA

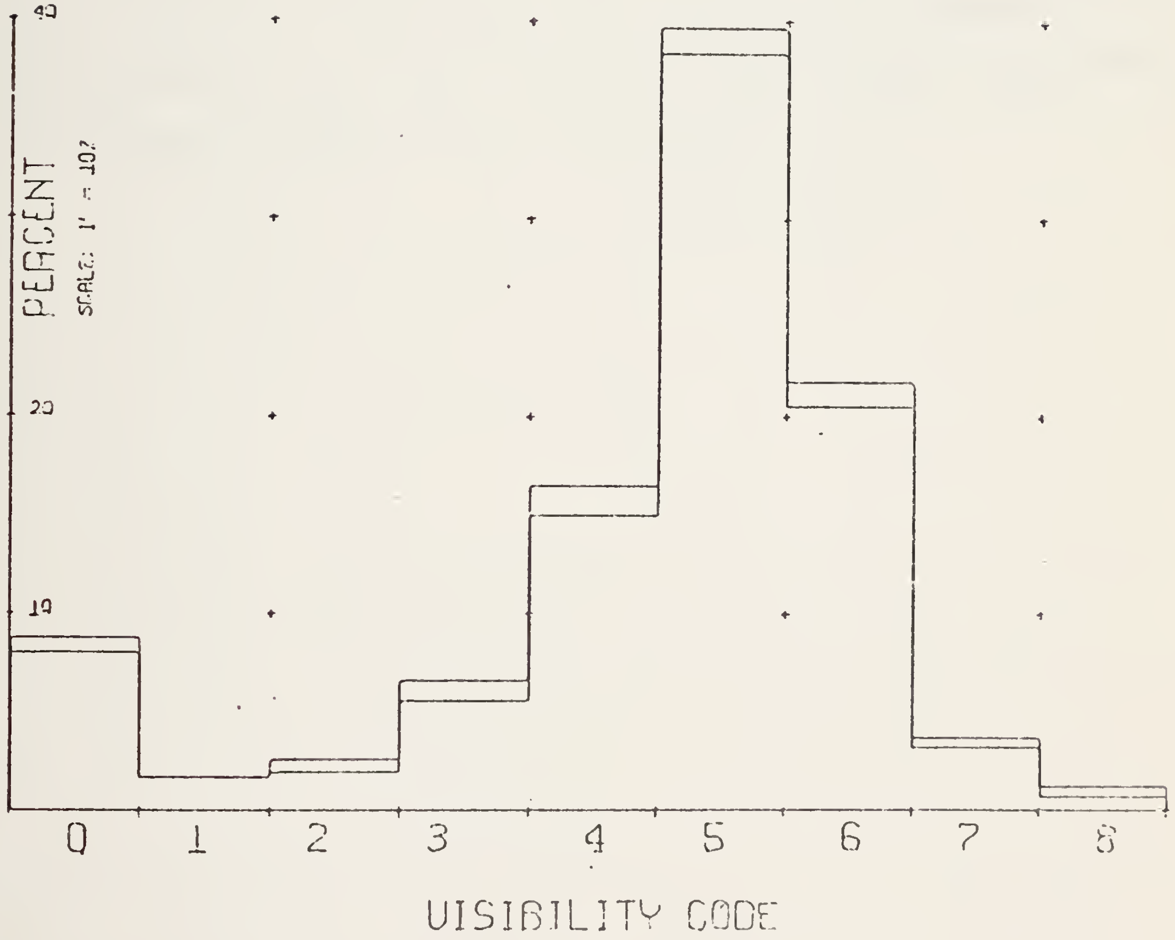


SEA STATE

CODE FREQUENCY DISTRIBUTIONS
HISTORICAL DATA 1970 - 1974
SIMULATION GENERATED DATA



VISIBILITY
CODE FREQUENCY DISTRIBUTIONS
HISTORICAL DATA 1970 - 1974
SIMULATION GENERATED DATA



APPENDIX D

Results of Analysis-of-Means Tests

(Estimation of Linear Contrasts)

The tables in this appendix are a graphic representation of the result of mathematical tests performed on the historic data and the simulation data. The estimation-of-linear-contrasts test was performed on each data element to determine if the means of the code values for each year were equal. The test was performed in the analysis-of-data chapter to determine if the means of the code values varied from year to year. It was performed in the validation-of-computer-model chapter to determine if the means of the code values generated by the computer model were different from the historic data. These tests are described in Bolch and Huang [Ref. 2].

ESTIMATION OF LINEAR CONTRASTS

GRAPHIC DEPICTION OF RESULTS OF CALCULATIONS

HISTORIC YEARS 1970 - 1974
AND
THREE YEARS SIMULATION

DATA ELEMENT: TIME OF DAY

	1970	1971	1972	1973	1974	RUN 1	RUN 2	RUN 3
1970	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X
1971	X X X				X X X	2	2	2 3
1972	X X X			1 2	X X X	2 3	2 3	2 3
1973	X X X				X X X			
1974	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X

CODE:

1 = DATA MEAN WAS SIGNIFICANTLY DIFFERENT FROM ALL OTHER HISTORIC YEARS.
2 = DATA MEAN WAS SIGNIFICANTLY DIFFERENT FROM ALL HISTORIC YEARS PLUS ONE SIMULATION RUN
3 = DATA MEAN WAS SIGNIFICANTLY DIFFERENT FROM ALL HISTORIC YEARS PLUS THREE SIMULATION RUNS
X = DATA WAS MISSING FOR THIS YEAR

ESTIMATION OF LINEAR CONTRASTS

GRAPHIC DEPICTION OF RESULTS OF CALCULATIONS

HISTORIC YEARS 1970 - 1974
AND
THREE YEARS SIMULATION

DATA ELEMENT: MONTH

	1970	1971	1972	1973	1974	RUN 1	RUN 2	RUN 3
1970	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X
1971	X X X		2 3		X X X			
1972	X X X			1 2 3	X X X			2
1973	X X X				X X X	2		
1974	X X X	X X X	X X X	X X X	X X X	X X X	X X X	X X X

CODE:
1 = DATA MEAN WAS SIGNIFICANTLY DIFFERENT FROM ALL OTHER HISTORIC YEARS.
2 = DATA MEAN WAS SIGNIFICANTLY DIFFERENT FROM ALL HISTORIC YEARS PLUS ONE SIMULATION RUN
3 = DATA MEAN WAS SIGNIFICANTLY DIFFERENT FROM ALL HISTORIC YEARS PLUS THREE SIMULATION RUNS

X = DATA WAS MISSING FOR THIS YEAR

```
                  ESTIMATION OF LINEAR CONTRASTS

           GRAPHIC DEPICTION OF RESULTS OF CALCULATIONS
                   HISTORIC YEARS 1970 - 1974
                              AND
                     THREE YEARS SIMULATION

                 DATA ELEMENT:  NATURE OF DISTRESS

          1970    1971    1972    1973    1974   RUN 1   RUN 2   RUN 3
       ------------------------------------------------------------------
       |       |       |       |       |       |       |       |       |
 1970  |       |       |       |       |       |       |       |       |
 1971  |       |       | 1 2 3 |       |       |       |       |       |
 1972  |       |       |       |       |       |   2   |    3  |       |
 1973  |       |       |       |       |       |       |       |       |
 1974  |       |       |       |       |       |       |       |       |
       ------------------------------------------------------------------
            CODE:     1 = DATA MEAN WAS SIGNIFICANTLY
                          DIFFERENT FROM ALL OTHER HISTORIC
                          YEARS.
                      2 = DATA MEAN WAS SIGNIFICANTLY
                          DIFFERENT FROM ALL HISTORIC YEARS
                          PLUS ONE SIMULATION RUN
                      3 = DATA MEAN WAS SIGNIFICANTLY
                          DIFFERENT FROM ALL HISTORIC YEARS PLUS
                          THREE SIMULATION YEARS.
```

```
                      ESTIMATION OF LINEAR CONTRASTS

               GRAPHIC DEPICTION OF RESULTS OF CALCULATIONS

                       HISTORIC YEARS 1970 - 1974
                                   AND
                         THREE YEARS SIMULATION

                  DATA ELEMENT:  SEVERITY TO PERSONNEL

          1970    1971    1972    1973    1974   RUN 1   RUN 2   RUN 3
       ----------------------------------------------------------------
1970   |       |       | 1 2   |       | 1 2   |       |       |   2   |
1971   |       |       | 1 2   |       | 1 2   |       |       |   2   |
1972   |       |       |       |       |       |       |   2   |       |
1973   |       |       |       |       |       |       |       |       |
1974   |       |       |       |       |       |       |   2   |       |
       ----------------------------------------------------------------

                CODE:     1 = DATA MEAN WAS SIGNIFICANTLY
                              DIFFERENT FROM ALL OTHER HISTORIC
                              YEARS.
                          2 = DATA MEAN WAS SIGNIFICANTLY
                              DIFFERENT FROM ALL HISTORIC YEARS
                              PLUS ONE SIMULATION RUN
                          3 = DATA MEAN WAS SIGNIFICANTLY
                              DIFFERENT FROM ALL HISTORIC YEARS PLUS
                              THREE SIMULATION RUNS
```

ESTIMATION OF LINEAR CONTRASTS

GRAPHIC DEPICTION OF RESULTS OF CALCULATIONS

HISTORIC YEARS 1970 - 1974
AND
THREE YEARS SIMULATION

DATA ELEMENT: SEVERITY TO PROPERTY

	1970	1971	1972	1973	1974	RUN 1	RUN 2	RUN 3
1970			1 2 3	1 2 3	1 2 3		2 3	
1971					1 2 3			
1972								
1973								
1974						2 3	2 3	2 3

CODE:

1 = DATA MEAN WAS SIGNIFICANTLY DIFFERENT FROM ALL OTHER HISTORIC YEARS.

2 = DATA MEAN WAS SIGNIFICANTLY DIFFERENT FROM ALL HISTORIC YEARS PLUS ONE SIMULATION RUN

3 = DATA MEAN WAS SIGNIFICANTLY DIFFERENT FROM ALL HISTORIC YEARS PLUS THREE SIMULATION RUNS.

```
                    ESTIMATION OF LINEAR CONTRASTS

              GRAPHIC DEPICTION OF RESULTS OF CALCULATIONS

                       HISTORIC YEARS 1970 - 1974
                         (ELEMENT NOT SIMULATED)

                    DATA ELEMENT:  DISTANCE OFFSHORE

          1970     1971     1972     1973     1974
        ---------------------------------------------
  1970  |        |        |        |        |  1     |
  1971  |        |        |  1     |        |        |
  1972  |        |        |        |  1     |  1     |
  1973  |        |        |        |        |        |
  1974  |        |        |        |        |        |
        ---------------------------------------------

            CODE:     1 = DATA MEAN WAS SIGNIFICANTLY
                          DIFFERENT FROM ALL OTHER HISTORIC
                          YEARS.
                      2 = DATA MEAN WAS SIGNIFICANTLY
                          DIFFERENT FROM ALL HISTORIC YEARS
                          PLUS ONE SIMULATION RUN
                      3 = DATA MEAN WAS SIGNIFICANTLY
                          DIFFERENT FROM ALL HISTORIC YEARS PLUS
                          THREE SIMULATION RUNS
```

```
                    ESTIMATION OF LINEAR CONTRASTS

          GRAPHIC DEPICTION OF RESULTS OF CALCULATIONS

                   HISTORIC YEARS 1970 - 1974
                     (ELEMENT NOT SIMULATED)

                     DATA ELEMENT:  LENGTH

        1970     1971     1972     1973     1974
     -------------------------------------------------
1970  |        |        |  1     |        |  1     |
1971  |        |        |  1     |        |  1     |
1972  |        |        |        |  1     |        |
1973  |        |        |  1     |        |  1     |
1974  |        |        |        |        |  1     |
     -------------------------------------------------

           CODE:      1 = DATA MEAN WAS SIGNIFICANTLY
                          DIFFERENT FROM ALL OTHER HISTORIC
                          YEARS.
                      2 = DATA MEAN WAS SIGNIFICANTLY
                          DIFFERENT FROM ALL HISTORIC YEARS
                          PLUS ONE SIMULATION RUN
                      3 = DATA MEAN WAS SIGNIFICANTLY
                          DIFFERENT FROM ALL HISTORIC YEARS PLUS
                          THREE SIMULATION RUNS
```

ESTIMATION OF LINEAR CONTRASTS

GRAPHIC DEPICTION OF RESULTS OF CALCULATIONS

HISTORIC YEARS 1970 - 1974
AND
THREE YEARS SIMULATION

DATA ELEMENT: WIND VELOCITY

	1970	1971	1972	1973	1974	RUN 1	RUN 2	RUN 3
1970		1 2 3	1 2 3					
1971			1 2 3	3	1 2 3	2 3	2 3	2 3
1972				3				
1973								
1974								

CODE:

1 = DATA MEAN WAS SIGNIFICANTLY DIFFERENT FROM ALL OTHER HISTORIC YEARS.

2 = DATA MEAN WAS SIGNIFICANTLY DIFFERENT FROM ALL HISTORIC YEARS PLUS ONE SIMULATION RUN

3 = DATA MEAN WAS SIGNIFICANTLY DIFFERENT FROM ALL HISTORIC YEARS PLUS THREE SIMULATION RUNS.

ESTIMATION OF LINEAR CONTRASTS

GRAPHIC DEPICTION OF RESULTS OF CALCULATIONS

HISTORIC YEARS 1970 - 1974
AND
THREE YEARS SIMULATION

DATA ELEMENT: SEA STATE

	1970	1971	1972	1973	1974	RUN 1	RUN 2	RUN 3
1970					1 2	3		
1971				1 2	1 2	3		
1972					3	3		
1973								
1974							2	2

CODE:

1 = DATA MEAN WAS SIGNIFICANTLY DIFFERENT FROM ALL OTHER HISTORIC YEARS.
2 = DATA MEAN WAS SIGNIFICANTLY DIFFERENT FROM ALL HISTORIC YEARS PLUS ONE SIMULATION RUN
3 = DATA MEAN WAS SIGNIFICANTLY DIFFERENT FROM ALL HISTORIC YEARS PLUS THREE SIMULATION RUNS.

ESTIMATION OF LINEAR CONTRASTS

GRAPHIC DEPICTION OF RESULTS OF CALCULATIONS

HISTORIC YEARS 1970 - 1974
AND
THREE YEARS SIMULATION

DATA ELEMENT: VISIBILITY

	1970	1971	1972	1973	1974	RUN 1	RUN 2	RUN 3
1970								
1971								
1972								
1973								
1974								

CODE:

1 = DATA MEAN WAS SIGNIFICANTLY DIFFERENT FROM ALL OTHER HISTORIC YEARS.

2 = DATA MEAN WAS SIGNIFICANTLY DIFFERENT FROM ALL HISTORIC YEARS PLUS ONE SIMULATION RUN

3 = DATA MEAN WAS SIGNIFICANTLY DIFFERENT FROM ALL HISTORIC YEARS PLUS THREE SIMULATION RUNS

APPENDIX E

Correlation Matrices
(Measures of Relationships Between Two Variables)

The tables in this appendix show the linear relationships between two data elements for the historic data from the years 1970 through 1974 for the Arcata area of interest. If one data element, such as the code value for sea state, always increased whenever another element, such as wind velocity, increased, the correlation would approach the value 1.0. If the value of the correlation coefficient is negative, it indicates a negative relationship.

CORRELATION MATRIX
(MEASURE OF LINEAR RELATIONSHIP)

1970 DATA

	NATURE OF DISTRESS	DISTANCE OFFSHORE	PERSONNEL SEVERITY	PROPERTY SEVERITY	SEA STATE	WIND VELOCITY	VISIBILITY	LENGTH
NATURE OF DISTRESS	1.00	0.24	0.24	-0.40	0.44	0.51	0.35	0.30
DISTANCE OFFSHORE	0.24	1.00	-0.08	-0.30	0.36	0.40	0.24	0.49
PERSONNEL SEVERITY	0.24	-0.08	1.00	0.52	0.22	0.10	0.02	-0.28
PROPERTY SEVERITY	-0.40	-0.30	0.52	1.00	-0.08	-0.17	-0.22	-0.38
SEA STATE	0.44	0.36	0.22	-0.08	1.00	0.77	0.33	0.28
WIND VELOCITY	0.51	0.40	0.10	-0.17	0.77	1.00	0.47	0.31
VISIBILITY	0.35	0.24	0.02	-0.22	0.33	0.47	1.00	0.21
LENGTH	0.30	0.49	-0.28	-0.38	0.28	0.31	0.21	1.00

CORRELATION MATRIX
(MEASURE OF LINEAR RELATIONSHIP)

1971 DATA

	NATURE OF DISTRESS	DISTANCE OFFSHORE	PERSONNEL SEVERITY	PROPERTY SEVERITY	SEA STATE	WIND VELOCITY	VISIBILITY	LENGTH
NATURE OF DISTRESS	1.00	0.76	0.24	-0.54	0.68	0.68	0.41	0.68
DISTANCE OFFSHORE	0.76	1.00	0.18	-0.47	0.70	0.78	0.47	0.68
PERSONNEL SEVERITY	0.24	0.18	1.00	0.45	0.33	0.33	0.22	-0.15
PROPERTY SEVERITY	-0.54	-0.47	0.45	1.00	-0.26	-0.30	-0.15	-0.61
SEA STATE	0.68	0.70	0.33	-0.26	1.00	0.86	0.48	0.47
WIND VELOCITY	0.68	0.78	0.33	-0.30	0.86	1.00	0.57	0.46
VISIBILITY	0.41	0.47	0.22	-0.15	0.48	0.57	1.00	0.18
LENGTH	0.68	0.68	-0.15	-0.61	0.47	0.46	0.18	1.00

CORRELATION MATRIX
(MEASURE OF LINEAR RELATIONSHIP)

1972 DATA

	NATURE OF DISTRESS	DISTANCE OFFSHORE	PERSONNEL SEVERITY	PROPERTY SEVERITY	SEA STATE	WIND VELOCITY	VISIBILITY	LENGTH
NATURE OF DISTRESS	1.00	0.34	0.31	-0.13	0.30	0.38	0.16	0.33
DISTANCE OFFSHORE	0.34	1.00	0.11	-0.02	0.50	0.67	0.11	0.58
PERSONNEL SEVERITY	0.31	0.11	1.00	0.63	0.39	0.15	0.11	0.00
PROPERTY SEVERITY	-0.13	-0.02	0.63	1.00	0.14	0.01	0.09	-0.07
SEA STATE	0.30	0.50	0.39	0.14	1.00	0.63	0.13	0.27
WIND VELOCITY	0.38	0.67	0.15	0.01	0.63	1.00	0.20	0.40
VISIBILITY	0.16	0.11	0.11	0.09	0.13	0.20	1.00	-0.08
LENGTH	0.33	0.58	0.00	-0.07	0.27	0.40	-0.08	1.00

CORRELATION MATRIX
(MEASURE OF LINEAR RELATIONSHIP)

1973 DATA

	NATURE OF DISTRESS	DISTANCE OFFSHORE	PERSONNEL SEVERITY	PROPERTY SEVERITY	SEA STATE	WIND VELOCITY	VISIBILITY	LENGTH
NATURE OF DISTRESS	1.00	0.20	0.48	-0.35	0.21	0.23	0.20	0.00
DISTANCE OFFSHORE	0.20	1.00	0.05	-0.19	0.41	0.50	0.11	0.53
PERSONNEL SEVERITY	0.48	0.05	1.00	0.23	0.13	0.10	0.01	-0.06
PROPERTY SEVERITY	-0.35	-0.19	0.23	1.00	-0.12	-0.07	-0.08	-0.06
SEA STATE	0.21	0.41	0.13	-0.12	1.00	0.63	0.19	0.46
WIND VELOCITY	0.23	0.50	0.10	-0.07	0.63	1.00	0.31	0.51
VISIBILITY	0.20	0.11	0.01	-0.08	0.19	0.31	1.00	0.07
LENGTH	0.00	0.53	-0.05	-0.06	0.46	0.51	0.07	1.00

CORRELATION MATRIX
(MEASURE OF LINEAR RELATIONSHIP)

1974 DATA

	NATURE OF DISTRESS	DISTANCE OFFSHORE	PERSONNEL SEVERITY	PROPERTY SEVERITY	SEA STATE	WIND VELOCITY	VISIBILITY	LENGTH
NATURE OF DISTRESS	1.00	-0.05	0.41	-0.35	0.22	0.10	0.08	-0.21
DISTANCE OFFSHORE	-0.05	1.00	0.13	0.14	0.26	0.15	0.03	0.41
PERSONNEL SEVERITY	0.41	0.13	1.00	0.47	0.34	0.22	0.09	-0#04
PROPERTY SEVERITY	-0.35	0.14	0.47	1.00	0.24	0.16	0.00	0.14
SEA STATE	0.22	0.26	0.34	0.24	1.00	0.46	-0.12	0.25
WIND VELOCITY	0.10	0.15	0.22	0.16	0.46	1.00	0.06	0.10
VISIBILITY	0.08	0.03	0.09	0.00	-0.12	0.06	1.00	-0.13
LENGTH	-0.21	0.41	-0.04	0.14	0.25	0.10	-0.13	1.00

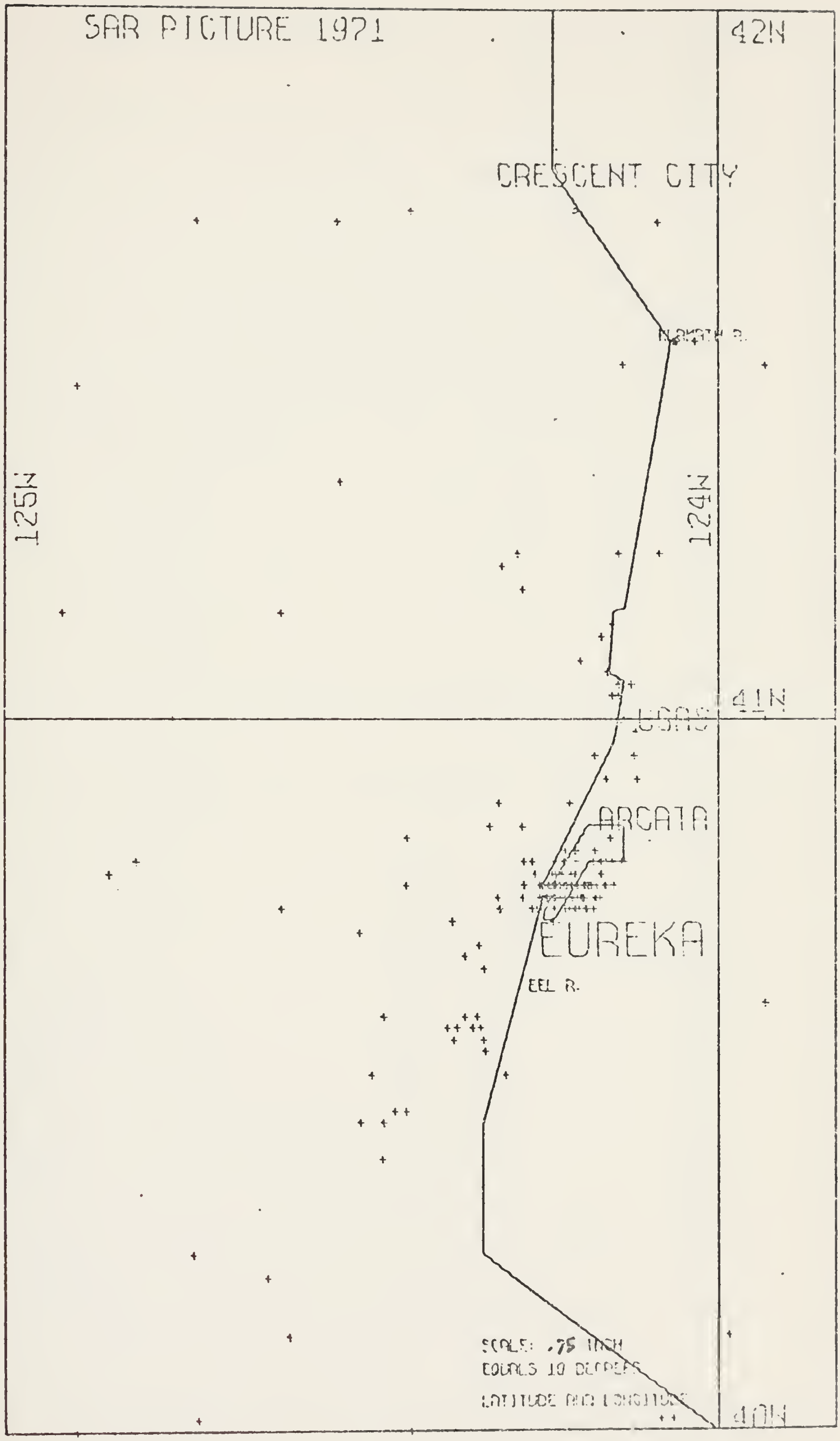
APPENDIX F

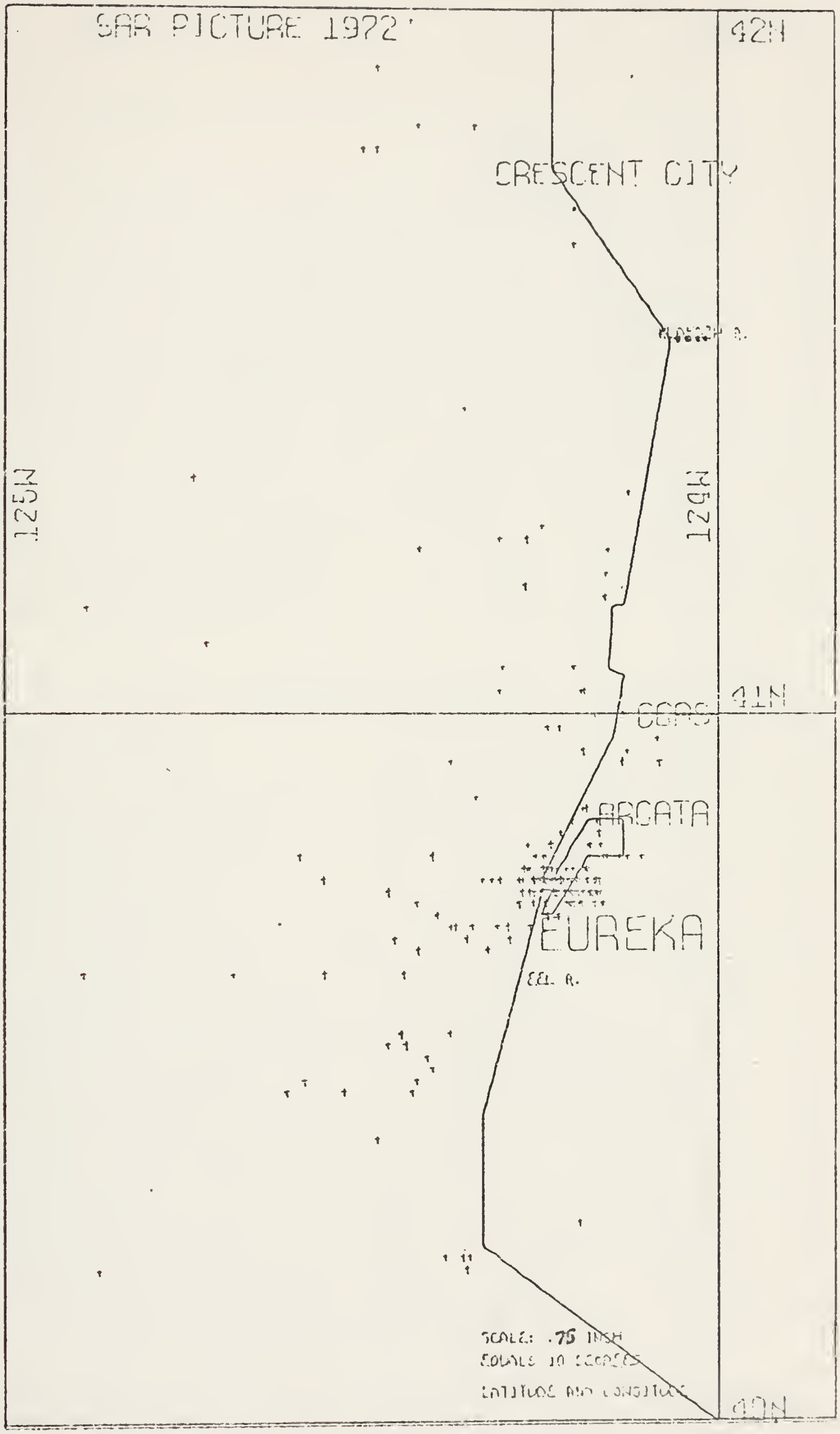
Charts of Positions of SAR Incidents

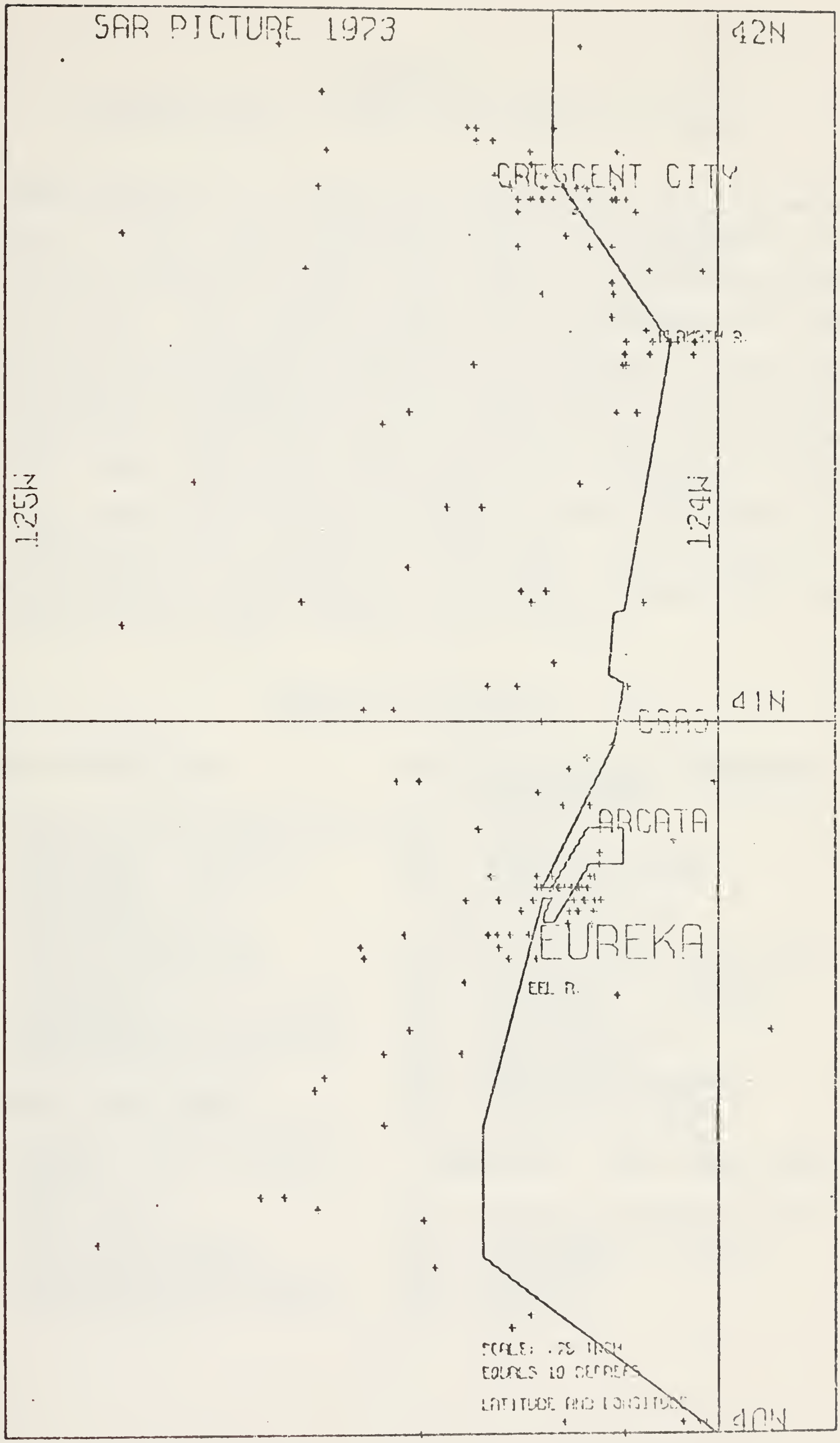
(1971 through 1973)

The following computer-generated charts are scaled approximations of positions of SAR incidents in the Arcata area of interest for the years 1971 through 1973. The charts are included only to show concentrations of positions and the relative positions of salient locations within the area of interest. Although not apparent on the charts, more than one-third of the distresses for each of the years occurred near the mouth of the Klamath River, just south of Crescent City.

These charts were drawn to scale using the CALCOMP Model 765. The software for drawing the charts was made available through the Plotting Package available at the Naval Postgraduate School [Ref. 15]. In order to draw the grid and the coastline, all points were stored in an array in the program which controlled the pen to draw the outlines. All data points and all labelling were done in the same manner. The program is highly adaptive; the author drew similiar charts for the activities of the Coast Guard in the San Diego and the San Francisco area.


SAR PICTURE 1971
42N
CRESCENT CITY
KLAMATH R.
125W
124W
41N
USAS
ARCATA
EUREKA
EEL R.
SCALE: .75 INCH
EQUALS 10 DEGREES
LATITUDE AND LONGITUDE
40N


SAR PICTURE 1972
42N
CRESCENT CITY
KLAMATH R.
125W
124W
41N
CGAS
ARCATA
EUREKA
EEL R.
SCALE: .75 INCH
EQUALS 10 DEGREES
LATITUDE AND LONGITUDE
40N


SAR PICTURE 1973
42N
CRESCENT CITY
KLAMATH R.
125W
124W
41N
CGAG
ARCATA
EUREKA
EEL R.
SCALE: .75 INCH
EQUALS 10 DEGREES
LATITUDE AND LONGITUDE
40N

APPENDIX G

Selected Code Values for Assistance Reports

This appendix is a table of code values for selected elements of the SAR environment which are reported on the Coast Guard Assistance Report (CG 3272). The elements which were selected were those which were analyzed in the data analysis chapter and those which were simulated. This table was included to illustrate to the reader who is not familiar with the Coast Guard SAR Assistance Report system the method in which the conditions are reported. It should be noted that the code values do not represent equal increments on the continuum of possible conditions. The spread of distance offshore, for example, is three miles for code value one and 150 miles for code value seven.

NATURE OF DISTRESS

Vessel Conditions

00 - Other vessel conditions
01 - Disabled, adrift
02 - Disabled, anchored
03 - Aground
04 - Capsized
05 - Fire/Explosion
06 - Flooding/Sinking
07 - Overdue/Missing
08 - Collision
09 - Unfamiliar with area/ Disoriented
11 - Endangered by weather
12 - Endangered by ice

Aircraft Conditions

20 - Other aircraft conds.
21 - Ditch/Forced landing
22 - Crash
23 - Low on fuel
24 - Bail out
25 - Fire/Explosion
27 - Overdue/Missing
28 - Mechanical casualty
29 - Unfamiliar with area/ Disoriented

Land or Offshore Structure Conditions

50 - Other,
51 - Flooding
55 - Fire,Explosion
57 - Missing

Diver Conditions

70 - Other diver conditions
71 - Stranded
72 - Personnel in water
73 - Bends
74 - Air Embolism
75 - Emphysema
76 - Equipment failure
77 - Overdue/Missing
78 - Predator attack

Personnel, Other than Diver

80 - Other personnel conds.
81 - Drowning
82 - Personnel in water
84 - Sickness
85 - Injury
87 - Missing

Land Vehicle Conditions

40 - Other land vehicle conds
42 - Crash (accident)
43 - Overdue/Missing

Miscellaneous Conditions

90 - Other conditions
98 - Flare sighting
99 - Unknown

DISTANCE OFFSHORE

0 - Land
1 - 0 - 3 miles
2 - 3.1 - 10 miles
3 - 10.1 - 25 miles
4 - 25.1 - 50 miles
5 - 50.1 - 100 miles
6 - 100.1 - 150 miles
7 - 150.1 - 300 miles
8 - Greater than 300 miles
9 - Unknown

SEVERITY OF DISTRESS - PERSONNEL

0 - None - No personnel were involved.
1 - Small - No immediate or foreseeable danger to personnel.
2 - Moderate - Some danger than personnel might be lost.
3 - Severe - Personnel were in danger of loss or were lost.
9 - Unknown.

SEVERITY OF DISTRESS - PROPERTY

0 - None - No property was involved.
1 - Small - No immediate danger to property.
2 - Moderate - Some danger that property might be lost.
3 - Severe - Property was in danger of loss or was lost.
9 - Unknown.

SEA STATE

0 - Calm
1 - 1 - 2 feet
2 - 3 - 4 feet
3 - 5 - 6 feet
4 - 7 - 10 feet
5 - 11 - 20 feet
6 - Greater than 20 feet.
8 - Land
9 - Unknown

WIND

0 - Calm
1 - 0.1 - 10 knots
2 - 10.1 - 20 knots
3 - 20.1 - 30 knots
4 - 30.1 - 40 knots
5 - 40.1 - 50 knots
6 - 50.1 - 60 knots
7 - 60.1 - 70 knots
8 - Over 70 knots
9 - Unknown

VISIBILITY

0 - 0 - 1/4 mile
1 - Greater than 1/4 - 1/2 mile
2 - Greater than 1/2 - 1 mile
3 - 1.1 - 3 miles
4 - 3.1 - 5 miles
5 - 5.1 - 10 miles
6 - 10.1 - 15 miles
7 - 15.1 - 20 miles
9 - Unknown

SAMPLE COMPUTER OUTPUT

The following is a sample output from the simulation program. It represents the cases generated for the month of March. In addition to the printed output shown, the program also punched a card with the elements of data punched in the same format as was found in the historic data which was received on cards. The cards which were punched were retained and used in the data analysis and validation of the simulation model.

```
TODAY IS THE  1 DAY OF MARCH
    TODAY IS SUNDAY
    THE NUMBER OF CASES FOR THIS DAY IS   0


TODAY IS THE  2 DAY OF MARCH
    TODAY IS MONDAY
    THE NUMBER OF CASES FOR THIS DAY IS   0


TODAY IS THE  3 DAY OF MARCH
    TODAY IS TUESDAY
    THE NUMBER OF CASES FOR THIS DAY IS   0


TODAY IS THE  4 DAY OF MARCH
    TODAY IS WEDESDAY
    THE NUMBER OF CASES FOR THIS DAY IS   0


TODAY IS THE  5 DAY OF MARCH
    TODAY IS THURSDAY
    THE NUMBER OF CASES FOR THIS DAY IS   0


TODAY IS THE  6 DAY OF MARCH
    TODAY IS FRIDAY
    THE NUMBER OF CASES FOR THIS DAY IS   1

    CASE  1 TIME OF INCIDENT IS 15 39.
THE NATURE OF DISTRESS IS VESSEL ADRIFT AND DISABLED.
SEVERITY TO PERSONNEL IS  2     SEVERITY TO PROPERTY IS  2
HELICOPTER WOULD BE USED ON THIS CASE.
SAR INCIDENT OCCURS LATITUDE  40 45 MINS NORTH, LONGITUDE 124 15 MINS WEST.
DISTANCE FROM AIR STA TO POSITION OF SAR INCIDENT IS     15.47 MILES.
ENROUTE TIME FOR HELICOPTER TO SCENE OF DISTRESS IS 0.2 HOURS.
THE DISTANCE TO SCENE FOR A SURFACE UNIT FROM HUMBOLT BAY IS   4.3
THE TIME REQUIRED FOR A SURFACE UNIT TO ARRIVE ON SCENE IS 0.2 HOURS.
THE DISTANCE OFFSHORE IS   3.8 MILES
THE VISIBILITY ON SCENE IS CODE  5 THE WIND ON SCENE IS CODE  1
THE SEA STATE ON SCENE IS CODE  0


TODAY IS THE  7 DAY OF MARCH
    TODAY IS SATURDAY
    THE NUMBER OF CASES FOR THIS DAY IS   0
```

```
TODAY IS THE  8 DAY OF MARCH
    TODAY IS SUNDAY
    THE NUMBER OF CASES FOR THIS DAY IS   0


TODAY IS THE  9 DAY OF MARCH
    TODAY IS MONDAY
    THE NUMBER OF CASES FOR THIS DAY IS   0


TODAY IS THE 10 DAY OF MARCH
    TODAY IS TUESDAY
    THE NUMBER OF CASES FOR THIS DAY IS   0


TODAY IS THE 11 DAY OF MARCH
    TODAY IS WEDESDAY
    THE NUMBER OF CASES FOR THIS DAY IS   2

    CASE  1 TIME OF INCIDENT IS 11  7.
NATURE OF DISTRESS IS MISCELLANEOUS VESSEL CONDITION.
SEVERITY TO PERSONNEL IS  1      SEVERITY TO PROPERTY IS  1

SAR INCIDENT OCCURS LATITUDE  40 20 MINS NORTH. DISTANCE TO SCENE IS  161.MILES
TIME FOR A SURFACE UNIT FROM HUMBOLT BAY TO ARRIVE ON SCENE IS  8.9 HOURS.
THE VISIBILITY ON SCENE IS CODE  5 THE WIND ON SCENE IS CODE  0
THE SEA STATE ON SCENE IS CODE  0

    CASE  2 TIME OF INCIDENT IS 15 45.
THE NATURE OF DISTRESS IS VESSEL ADRIFT AND DISABLED.
SEVERITY TO PERSONNEL IS  1      SEVERITY TO PROPERTY IS  1
SAR INCIDENT OCCURS LATITUDE  40 45 MINS NORTH, LONGITUDE 124 20 MINS WEST.
THE DISTANCE TO SCENE FOR A SURFACE UNIT FROM HUMBOLT BAY IS   7.8
THE TIME REQUIRED FOR A SURFACE UNIT TO ARRIVE ON SCENE IS 0.4 HOURS.
THE DISTANCE OFFSHORE IS   7.5 MILES
THE VISIBILITY ON SCENE IS CODE  0 THE WIND ON SCENE IS CODE  0
THE SEA STATE ON SCENE IS CODE  0


TODAY IS THE 12 DAY OF MARCH
    TODAY IS THURSDAY
    THE NUMBER OF CASES FOR THIS DAY IS   0


TODAY IS THE 13 DAY OF MARCH
    TODAY IS FRIDAY
    THE NUMBER OF CASES FOR THIS DAY IS   0
```

```
TODAY IS THE 14 DAY OF MARCH
    TODAY IS SATURDAY
    THE NUMBER OF CASES FOR THIS DAY IS   0


TODAY IS THE 15 DAY OF MARCH
    TODAY IS SUNDAY
    THE NUMBER OF CASES FOR THIS DAY IS   0


TODAY IS THE 16 DAY OF MARCH
    TODAY IS MONDAY
    THE NUMBER OF CASES FOR THIS DAY IS   2

    CASE  1 TIME OF INCIDENT IS  6  5.
THE NATURE OF DISTRESS IS VESSEL ADRIFT AND DISABLED.
SEVERITY TO PERSONNEL IS  1     SEVERITY TO PROPERTY IS  1
SAR INCIDENT OCCURS LATITUDE  40 15 MINS NORTH, LONGITUDE 124 30 MINS WEST.
THE DISTANCE TO SCENE FOR A SURFACE UNIT FROM HUMBOLT BAY IS  35.4
THE TIME REQUIRED FOR A SURFACE UNIT TO ARRIVE ON SCENE IS 2.0 HOURS.
THE DISTANCE OFFSHORE IS  15.1 MILES
THE VISIBILITY ON SCENE IS CODE  5 THE WIND ON SCENE IS CODE  2
THE SEA STATE ON SCENE IS CODE  2

    CASE  2 TIME OF INCIDENT IS 23  5.
THE NATURE OF DISTRESS IS VESSEL ADRIFT AND DISABLED.
SEVERITY TO PERSONNEL IS  2     SEVERITY TO PROPERTY IS  2
HELICOPTER WOULD BE USED ON THIS CASE.
SAR INCIDENT OCCURS LATITUDE  41 30 MINS NORTH, LONGITUDE 124 30 MINS WEST.
DISTANCE FROM AIR STA TO POSITION OF SAR INCIDENT IS     35.38 MILES.
ENROUTE TIME FOR HELICOPTER TO SCENE OF DISTRESS IS 0.4 HOURS.
THE DISTANCE TO SCENE FOR A SURFACE UNIT FROM HUMBOLT BAY IS  22.7
THE TIME REQUIRED FOR A SURFACE UNIT TO ARRIVE ON SCENE IS 1.3 HOURS.
THE DISTANCE OFFSHORE IS  15.1 MILES
THE VISIBILITY ON SCENE IS CODE  0 THE WIND ON SCENE IS CODE  0
THE SEA STATE ON SCENE IS CODE  0


TODAY IS THE 17 DAY OF MARCH
    TODAY IS TUESDAY
    THE NUMBER OF CASES FOR THIS DAY IS   0


TODAY IS THE 18 DAY OF MARCH
    TODAY IS WEDESDAY
    THE NUMBER OF CASES FOR THIS DAY IS   0
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TODAY IS THE 19 DAY OF MARCH
     TODAY IS THURSDAY
     THE NUMBER OF CASES FOR THIS DAY IS   2

     CASE  1 TIME OF INCIDENT IS 11 26.
THE NATURE OF DISTRESS IS OVERDUE OR MISSING VESSEL.
SEVERITY TO PERSONNEL IS  3      SEVERITY TO PROPERTY IS  3
HELICOPTER WOULD BE USED ON THIS CASE.
SAR INCIDENT OCCURS LATITUDE  40 50 MINS NORTH, LONGITUDE 124 15 MINS WEST.
DISTANCE FROM AIR STA TO POSITION OF SAR INCIDENT IS     10.69 MILES.
ENROUTE TIME FOR HELICOPTER TO SCENE OF DISTRESS IS 0.1 HOURS.
THE DISTANCE TO SCENE FOR A SURFACE UNIT FROM HUMBOLT BAY IS    4.8
THE TIME REQUIRED FOR A SURFACE UNIT TO ARRIVE ON SCENE IS 0.3 HOURS.
THE DISTANCE OFFSHORE IS    3.8 MILES
THE VISIBILITY ON SCENE IS CODE  6 THE WIND ON SCENE IS CODE  1
THE SEA STATE ON SCENE IS CODE  4

     CASE  2 TIME OF INCIDENT IS 17  5.
THE NATURE OF DISTRESS IS VESSEL ADRIFT AND DISABLED.
SEVERITY TO PERSONNEL IS  1      SEVERITY TO PROPERTY IS  1
SAR INCIDENT OCCURS LATITUDE  41 45 MINS NORTH, LONGITUDE 124 20 MINS WEST.
THE DISTANCE TO SCENE FROM CRESCENT CITY IS    7.5 MILES.
THE TIME REQUIRED FOR A SURFACE UNIT TO ARRIVE ON SCENE IS 0.4 HOURS.
THE DISTANCE OFFSHORE IS    7.5 MILES
THE VISIBILITY ON SCENE IS CODE  5 THE WIND ON SCENE IS CODE  1
THE SEA STATE ON SCENE IS CODE  0


TODAY IS THE 20 DAY OF MARCH
     TODAY IS FRIDAY
     THE NUMBER OF CASES FOR THIS DAY IS   0


TODAY IS THE 21 DAY OF MARCH
     TODAY IS SATURDAY
     THE NUMBER OF CASES FOR THIS DAY IS   0


TODAY IS THE 22 DAY OF MARCH
     TODAY IS SUNDAY
     THE NUMBER OF CASES FOR THIS DAY IS   0


TODAY IS THE 23 DAY OF MARCH
     TODAY IS MONDAY
     THE NUMBER OF CASES FOR THIS DAY IS   1
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    CASE  1 TIME OF INCIDENT IS  8 28.
THE NATURE OF DISTRESS IS VESSEL ADRIFT AND DISABLED.
SEVERITY TO PERSONNEL IS  1      SEVERITY TO PROPERTY IS  1
SAR INCIDENT OCCURS LATITUDE  41 35 MINS NORTH, LONGITUDE 124  5 MINS WEST.
THE DISTANCE TO SCENE FROM CRESCENT CITY IS  10.7 MILES.
THE TIME REQUIRED FOR A SURFACE UNIT TO ARRIVE ON SCENE IS 0.6 HOURS.
THE DISTANCE OFFSHORE IS   3.8 MILES
THE VISIBILITY ON SCENE IS CODE  5 THE WIND ON SCENE IS CODE  1
THE SEA STATE ON SCENE IS CODE  0


TODAY IS THE 24 DAY OF MARCH
    TODAY IS TUESDAY
    THE NUMBER OF CASES FOR THIS DAY IS   0


TODAY IS THE 25 DAY OF MARCH
    TODAY IS WEDESDAY
    THE NUMBER OF CASES FOR THIS DAY IS   0


TODAY IS THE 26 DAY OF MARCH
    TODAY IS THURSDAY
    THE NUMBER OF CASES FOR THIS DAY IS   0


TODAY IS THE 27 DAY OF MARCH
    TODAY IS FRIDAY
    THE NUMBER OF CASES FOR THIS DAY IS   2

    CASE  1 TIME OF INCIDENT IS 10 18.
THE NATURE OF DISTRESS IS VESSEL ADRIFT AND DISABLED.
SEVERITY TO PERSONNEL IS  1      SEVERITY TO PROPERTY IS  1
SAR INCIDENT OCCURS LATITUDE  41 35 MINS NORTH, LONGITUDE 124  5 MINS WEST.
THE DISTANCE TO SCENE FROM CRESCENT CITY IS  10.7 MILES.
THE TIME REQUIRED FOR A SURFACE UNIT TO ARRIVE ON SCENE IS 0.6 HOURS.
THE DISTANCE OFFSHORE IS   3.8 MILES
THE VISIBILITY ON SCENE IS CODE  6 THE WIND ON SCENE IS CODE  2
THE SEA STATE ON SCENE IS CODE  1

    CASE  2 TIME OF INCIDENT IS 15 40.
THE NATURE OF DISTRESS IS VESSEL ADRIFT AND DISABLED.
SEVERITY TO PERSONNEL IS  1      SEVERITY TO PROPERTY IS  1
SAR INCIDENT OCCURS LATITUDE  41 35 MINS NORTH, LONGITUDE 124  5 MINS WEST.
THE DISTANCE TO SCENE FROM CRESCENT CITY IS  10.7 MILES.
THE TIME REQUIRED FOR A SURFACE UNIT TO ARRIVE ON SCENE IS 0.6 HOURS.
THE DISTANCE OFFSHORE IS   3.8 MILES
THE VISIBILITY ON SCENE IS CODE  1 THE WIND ON SCENE IS CODE  1
```

```
THE SEA STATE ON SCENE IS CODE  1


TODAY IS THE 28 DAY OF MARCH
    TODAY IS SATURDAY
    THE NUMBER OF CASES FOR THIS DAY IS   1

    CASE  1 TIME OF INCIDENT IS 17 40.
THE NATURE OF DISTRESS IS VESSEL DISABLED AND ANCHORED.
SEVERITY TO PERSONNEL IS  1     SEVERITY TO PROPERTY IS  1
SAR INCIDENT OCCURS LATITUDE  40 55 MINS NORTH, LONGITUDE 124 15 MINS WEST.
THE DISTANCE TO SCENE FOR A SURFACE UNIT FROM HUMBOLT BAY IS    8.8
THE TIME REQUIRED FOR A SURFACE UNIT TO ARRIVE ON SCENE IS 0.5 HOURS.
THE DISTANCE OFFSHORE IS   3.8 MILES
THE VISIBILITY ON SCENE IS CODE  6 THE WIND ON SCENE IS CODE  1
THE SEA STATE ON SCENE IS CODE  1



THE TOTAL CASES GENERATED FOR THIS PERIOD IS:  11  TOTAL CASES WITH HELO IS   3
```

```
C                       COMPUTER PROGRAMS
C
C
C                 A COMPUTER PROGRAM TO SIMULATE
C              THE SEARCH AND RESCUE ENVIRONMENT
C                          OF THE
C                PROPOSED COAST GUARD AIR STATION
C                            AT
C                     ARCATA, CALIFORNIA
C
C
C
C************************************************************C
C
      DIMENSION LLIND(288),XCUM(288)
      DIMENSION WXNR(729), ISTATE(729)
      DIMENSION HYST(23),HCUM(23,16)
      DIMENSION XTIME(24)
      DIMENSION AVG(12,28)
C
C        ILAND IS AN INDICATOR TO SHOW IF A CASE
C             HAPPENED ON LAND.
C        IFLAG IS AN INDICATOR USED IN SUBROUTINE
C             LATLON TO SHOW THAT THE POSITION OF A
C             SAR INCIDENT WAS FARTHER WEST THAN
C             125-00W.
C        IAIR  IS AN INDICATOR TO SHOW IF A HELO
C             WOULD BE LAUNCHED ON THIS CASE DUE
C             TO THE SEVERITY.
C        ITOTCS IS A COUNTER FOR THE TOTAL CASES.
C        IHELCS IS A COUNTER FOR HELICOPTER CASES.
C
      ILAND = 0
      IFLAG = 0
      ITOTCS = 0
      IHELCS = 0
      IAIR = 0
C
C
C        THIS SECTION ESTABLISHES COMMON STORAGE
C        FOR THE DATA WHICH WILL BE USED IN SEVERAL
C        SUBROUTINES.
C
C
      COMMON /COM1/XCUM
      COMMON /COM2/ISEED
      COMMON /COM3/ISTATE
      COMMON /COM4/WXNR
      COMMON /COM5/ HYST
      COMMON /COM6/HCUM
      COMMON /COM7/LAT
      COMMON /COM8/MINS
      COMMON /COM9/LMINS
      COMMON /COM10/XTIME
      COMMON /COM11/NCASES
      COMMON /COM12/AVG
      COMMON /COM13/DIST
      COMMON /COM14/ILAND
      COMMON /COM15/IHELCS
      COMMON /COM16/IAIR
      COMMON /COM17/ISEA
      COMMON /COM18/IWIND
      COMMON /COM19/IVIZ
      COMMON /COM20/IPER
      COMMON /COM21/MEW
      COMMON /COM22/NTYM
      COMMON /COM23/NODES
      COMMON /COM24/IPROP
      COMMON /COM25/LLIND
      COMMON /COM26/ DDDIST
C
C
```

```
      CALL OVFLOW
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                          C
C        THE HISTORICAL CUMULATIVE DISTRIBUTIONS           C
C        FOR THE LATITUDE AND LONGITUDE OF THE SAR         C
C        INCIDENTS FOR THE AREA OF CONSIDERATION           C
C        FOR THE ARCATA COAST GUARD AIR STATION            C
C        (LAT 40-00N TO LAT 41-00N,LONG 124-00W TO         C
C        LONG 125-00W) ARE READ OFF CARDS AND STORED       C
C        IN AN ARRAY CALLED XCUM WITH A SIZE OF            C
C        288 (12 X 24) LOCATIONS.  THIS MEANS THAT         C
C        EACH OF THE 288 SQUARES REPRESENTS A              C
C        AREA FIVE DEGREES IN LATITUDE BY FIVE             C
C        DEGREES IN LONGITUDE.  THE CUMULATIVE             C
C        NUMBERS IN THE STORAGE LOCATIONS REPRESENT        C
C        THE NUMBER OF CASES WHICH OCCURRED IN THE         C
C        YEARS 1971 THROUGH 1973 IN THAT AREA.             C
C
      READ (5,100) (XCUM(I),I=1,288)
  100 FORMAT (12(F5.1))
      DO 10 N = 1,288
      LLIND(N) = N
   10 CONTINUE
C
C                                                          C
C        AN ARRAY CALLED ISTATE IS FILLED WITH             C
C        NUMBERS WHICH IDENTIFY EACH ARRAY LOCATION.       C
C        THIS ARRAY WILL BE USED IN SUBROUTINE             C
C        NATURE TO CALCULATE WEATHER CONDITIONS.           C
C                                                          C
C        THE HISTORICAL DISTRIBUTION OF WEATHER CON-       C
C        DITIONS(WIND VELOCITY, SEA STATE, AND VISI-       C
C        BILITY)IS READ OFF CARDS AND STORED IN AN         C
C        ARRAY CALLED WXNR OF SIZE729 (9 X 9 X 9).         C
C        THE DISTRIBUTION IS BASED ON THE OBSERVED         C
C        WEATHER AT THE SCENE OF SAR INCIDENTS IN          C
C        THE AREA OF STUDY FOR THE YEARS 1970 TO           C
C        1974.                                             C
C
      DO 20 I = 1,729
      ISTATE(I) = I
   20 CONTINUE
      READ(5,200) (WXNR(I),I = 1,729)
  200 FORMAT (9(F7.3))
C
C        THE "NATURE OF DISTRESS" HISTORICAL CUMU-         C
C        LATIVE DISTRIBUTION IS READ OFF CARDS ALONG       C
C        WITH THE CUMULATIVE DISTRIBUTIONS OF DEGREE       C
C        OF SEVERITY.  THE DATA IS BASED UPON FIVE         C
C        FIVE YEARS SAR ACTIVITY.  THE NATURE OF           C
C        DISTRESS ARRAY--HYST--IS OF SIZE 23.              C
C        BECAUSE SOME OF THE POSSIBLE TYPES OF             C
C        DISTRESS DID NOT OCCUR IN THE EUREKA AREA         C
C        IN THE FIVE YEARS HISTORICAL DATA, THEY           C
C        ARE PRESUMED NEVER TO OCCUR IN THE RUNNING        C
C        OF THE MODEL. EACH TYPE OF DISTRESS HAS A         C
C        4 X 4 MATRIX REPRESENTING DEGREE OF SEVER-        C
C        ITY FOR THAT TYPE OF DISTRESS.  THE SIZE          C
C        OF THE STORAGE REPRESENTING DEGREE OF SEVER-      C
C        IS 23 X 16.                                       C
C                                                          C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      READ (5,300) (HYST(K),K=1,23)
  300 FORMAT (8F10.2)
      DO 30 K = 1,23
      READ(5,400) (HCUM(K,J),J=1,16)
  400 FORMAT(16(F5.2))
   30 CONTINUE
C
```

```
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                            C
C        THE FIRST STEP OF THE SAR SIMULATION IS TO          C
C        GENERATE THE TIME OF THE DISTRESS.  BY DATA         C
C        ANALYSIS IT WAS DETERMINED THAT THE PRO-            C
C        BABILITY OF A SAR INCIDENT OCCURRANCE               C
C        VARIED HOUR BY HOUR, DAY BY DAY, AND MONTH          C
C        BY MONTH.  IN ORDER TO SIMULATE THE SAR             C
C        OCCURANCES WHILE KEEPING THE MODEL WITHIN           C
C        REASONABLE BOUNDS THE FISCAL YEAR DATA WAS          C
C        ADAPTED TO A "MODEL YEAR". THE MODEL YEAR           C
C        CONSISTS OF 336 DAYS. EACH OF TWELVE MONTHS         C
C        HAS FOUR WEEKS EACH OF WHICH HAS SEVEN DAYS.        C
C        THE FIRST OF EACH MONTH IS A SUNDAY, AND    .       C
C        EACH SEVENTH DAY IS A SUNDAY.  EACH MONTH           C
C        HAS 28 DAYS.                                        C
C                                                            C
      CONTINUE
C        IN ORDER TO DETERMINE THE DISTRIBUTIONS OF          C
C        SAR INCIDENTS FOR THE MODEL YEAR, THE SAR           C
C        DATA FOR FOUR YEARS WAS ANALYZED.  THE WEEK         C
C        OF EACH CALENDAR MONTH WAS REARRANGED SO            C
C        THAT IT CORRESPONDED TO THE MODEL YEAR AND          C
C        THE SAR OCCURANCES HAPPENING, FOR INSTANCE          C
C        ON THE SECOND MONDAY OF JUNE FOR EACH OF            C
C        THE FOUR YEARS WAS AVERAGED IN ORDER TO             C
C        OBTAIN THE AVERAGE (EXPECTED) NUMBER OF             C
C        SAR OCCURANCES FOR THAT DAY.  THESE FIGURES         C
C        ARE READ INTO AN ARRAY CALLED AVG(M,N).             C
C        "M" IS THE MONTH NUMBER AND "N" IS THE DAY          C
C        NUMBER.                                             C
C                                                            C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      DC 40 M = 1,12
      READ (5,500) (AVG(M,N),N = 1,28)
  500 FORMAT (16F5.1,/12F5.1)
   40 CONTINUE
C
C
C        THE HISTORICAL CUMULATIVE DISTRIBUTION OF           C
C        TIMES OF DAY FOR SAR INCIDENTS IS READ INTO         C
C        AN ARRAY CALLED ITIME.
C
      READ (5,600)(XTIME(I),I=1,24)
  600 FORMAT (16F5.1,/8F5.1)
C
C
C************************************************************C
C
C             EXECUTION OF SIMULATION BEGINS
C
C************************************************************C
C
C
C        THE SIMULATION IS INSTRUCTED TO  RUN FOR            C
C        TWELVE MONTHS OF TWENTY-EIGHT DAYS EACH.            C
C
      DC 70 M = 1,12
      DO 70 N = 1,28
C                                                            C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                            C
C        AS THE MODEL PROGRESSES THROUGH THE YEAR,           C
C        THE CALENDAR IS ADVANCED.  A SUBROUTINE             C
C        IS CALLED TO PRINT OUT THE DATE, THE DAY OF         C
C        WEEK, AND THE MONTH.                                C
C                                                            C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      CALL DATE (M,N)
```

```
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                          C
C        SUBROUTINE ICASES IS CALLED TO DETERMINE          C
C        THE NUMBER OF CASES (NCASES) WHICH WILL           C
C        OCCUR DURING THE CURRENT MODEL DAY.               C
C        IN ORDER TO DETERMINE THE NUMBER OF CASES         C
C        WHICH WILL OCCUR, THE SUBROUTINE IS PASSED        C
C        THE AVERAGE NUMBER OF CASES WHICH OCCURRED        C
C        ON THIS MODEL DAY FROM THE HISTORICAL             C
C        CUMULATION ARRAY AVG(M,N).                        C
C                                                          C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      CALL ICASES (M,N)
      IF (NCASES.LT.1) GO TO 70
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                          C
C        THE NEXT TASK IS TO DETERMINE WHAT TIMES          C
C        OF THE DAY THAT THE CASES WILL OCCUR.  FROM       C
C        HISTORICAL DATA IT CAN BE DETERMINED WHAT         C
C        THE DISTRIBUTIONS OF SAR OCCURANCES ARE.          C
C        GIVEN THE  NUMBER OF CASES THAT WILL OCCUR        C
C        ON ANY DAY (NCASES) THE NEXT STEP IS TO           C
C        SIMULATE AT WHAT TIMES THEY WILL OCCUR.           C
C        SUBROUTINE NTIME IS CALLED TO DETERMINE           C
C        WHAT TIMES OF DAY THE SAR INCIDENTS WILL          C
C        OCCUR.                                            C
C                                                          C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      DO 71 NCSE = 1,NCASES
      CALL NTIME (NCSE)
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                         C
C        SUBROUTINE NATURE IS CALLED IN ORDER TO          C
C             DETERMINE THE NATURE OF DISTRESS.           C
C        SUBROUTINE LATLON IS CALLED TO GENERATE          C
C             THE LATITUDE AND LONGITUDE OF THE SAR       C
C             INCIDENT.  IFLAG IS A MARKER WHICH          C
C             IS USED TO INDICATE THAT NATURE HAS         C
C             GENERATED A CASE WHICH OCCURS INLAND.       C
C        SUBROUTINE DISTNC COMPUTES AND PRINTS THE        C
C             DISTANCE FROM COAST GUARD STATIONS          C
C             TO THE SCENE OF DISTRESS.                   C
C        SUBROUTINE WEATHR GENERATES THE WEATHER AT THE   C
C             SCENE OF DISTRESS.                          C
C                                                         C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      CALL NATURE
      CALL LATLON (IFLAG)
      IF (IFLAG.EQ.1) GO TO 50
      CALL DISTNC
   50 CALL WEATHR
      IFLAG = 0
      ILAND = 0
      IAIR = 0
      ITOTCS = ITOTCS + 1
C
C        DATA CARD IS PUNCHED.
C
      WRITE (7,700) M,N,NTYM,NODES,MEW,LAT,MINS,LMINS,IPER,
     1IPROP,ISEA,IWIND,IVIZ,DDDIST
  700 FORMAT(16X,I2,3X,2I2,6X,I2,I1,2I2,3X,I2,1X,2I1,1X,3I1,
     14X,F4.0)
   71 CONTINUE
   70 CONTINUE
```

```
C
C
C          THE SUMMARY OF THE OPERATIONS OF THE PERIOD                 C
C          IS PRINTED.                                                 C
C
      WRITE (6,800) ITOTCS, IHELCS
  800 FORMAT (///' THE TOTAL CASES GENERATED FOR THIS ',
     1'PERIOD IS: ',I3, '  TOTAL CASES WITH HELO IS ',I3)
      STOP
      END
```

```
C***********************************************************C
C                                                           C
      SUBROUTINE DATE (M,N)
C                                                           C
C***********************************************************C
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                           C
C        THIS SUBROUTINE RECEIVES THE VALUES "M"            C
C        AND "N" FROM THE MAIN PROGRAM.  "M" IS THE         C
C        MONTH NUMBER (1 TO 12) AND "N" IS THE DAY          C
C        NUMBER (1 TO 28). IT TRANSFORMS THESE NUMBERS      C
C        AND PRINTS THE CORRECT DATE,DAY, AND MONTH.        C
C                                                           C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      REAL*8 DAY(7)/'SUNDAY','MONDAY','TUESDAY','WEDESDAY',
     1'THURSDAY','FRIDAY','SATURDAY'/
C
      REAL*8 MONTH(12)/'JANUARY','FEBRUARY','MARCH','APRIL',
     1'MAY','JUNE','JULY','AUGUST','SEPT.','OCTOBER',
     2'NOVEMBER','DECEMBER'/
C
      WRITE (6,100) N,MONTH(7)
  100 FORMAT (//' TODAY IS THE ',I2,' DAY OF ',A8)
      IF(N.EQ.1.OR.N.EQ.8.OR.N.EQ.15.OR.N.EQ.22) GO TO 11
      IF(N.EQ.2.OR.N.EQ.9.OR.N.EQ.16.OR.N.EQ.23) GO TO 12
      IF(N.EQ.3.OR.N.EQ.10.OR.N.EQ.17.OR.N.EQ.24) GO TO 13
      IF(N.EQ.4.OR.N.EQ.11.OR.N.EQ.18.OR.N.EQ.25) GO TO 14
      IF(N.EQ.5.OR.N.EQ.12.OR.N.EQ.19.OR.N.EQ.26) GO TO 15
      IF(N.EQ.6.OR.N.EQ.13.OR.N.EQ.20.OR.N.EQ.27) GO TO 16
      IF(N.EQ.7.OR.N.EQ.14.OR.N.EQ.21.OR.N.EQ.28) GO TO 17
   11 WRITE (6,19) DAY(1)
      GO TO 99
   12 WRITE (6,19) DAY(2)
      GO TO 99
   13 WRITE (6,19) DAY(3)
      GO TO 99
   14 WRITE (6,19) DAY(4)
      GO TO 99
   15 WRITE (6,19) DAY(5)
      GO TO 99
   16 WRITE (6,19) DAY(6)
      GO TO 99
   17 WRITE (6,19) DAY(7)
      GO TO 99
   19 FORMAT ('      TODAY IS ',A8)
   99 RETURN
      END
```

```
C*********************************************************C
C                                                         C
      SUBROUTINE ICASES (M,N)
C                                                         C
C*********************************************************C
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                         C
C        THIS SUBROUTINE RECEIVES THE AVERAGE NUMBER      C
C        OF CASES WHICH HAVE OCCURRED ON THIS DAY         C
C        AS DAVG.  FROM THIS NUMBER IT GENERATES          C
C        THE NUMBER OF CASES WHICH WILL OCCUR IN THE      C
C        SIMULATION MODEL.  IT RETURNS THIS NUMBER        C
C        TO THE MAIN PROGRAM AS NCASES.                   C
C                                                         C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C
      COMMON /COM2/ISEED
      COMMON /COM11/NCASES
      COMMON /COM12/AVG
      DIMENSION AVG(12,28)
C
      DAVG = AVG(M,N)
      A  = EXP(-DAVG)
      S = 1.0
      NCASES = 0
   10 CALL RANDOM (ISEED,U,1)
      S = S * U
      IF (S.LT.A) GO TO 99
      NCASES = NCASES + 1
      GO TO 10
   99 WRITE (6,100) NCASES
  100 FORMAT ('     THE NUMBER OF CASES FOR THIS DAY IS  ',
     1I2)
      RETURN
      END
```

```
C
C
C*******************************************************C
C                                                       C
      SUBROUTINE NTIME (NCSE)
C                                                       C
C*******************************************************C
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                       C
C        SUBROUTINE NTIME DETERMINES THE TIMES THAT     C
C        THE SAR INCIDENTS HAPPEN ON ANY GIVEN DAY.     C
C        STORED IN A COMMON STORAGE LOCATION IN THE     C
C        THE SUBROUTINE IS THE NUMBER OF CASES OR       C
C        INCIDENTS WHICH WILL OCCUR.  THE SUBROUTINE    C
C        FIRST DETERMINES IF THERE ARE MORE THAN ONE    C
C        INCIDENTS FOR THE DAY.  IF NOT, THE SUB-       C
C        ROUTINE GENERATES ONE RANDOM NUMBER, AND       C
C        COMPARES THIS NUMBER AGAINST THE CUMULATIVE    C
C        DISTRIBUTION STORED IN XTIME TO DETERMINE      C
C        WHAT TIME OF DAY THE CASE WILL HAPPEN. IT      C
C        THEN GENERATES A NUMBER AND CONVERTS THIS      C
C        TO THE MINUTE VALUE.  THE SUBROUTINE NEXT      C
C        PRINTS THE CASE NUMBER FOR THE DAY, THE        C
C        HOUR AND THE MINUTE OF THE CASE.               C
      CONTINUE
C        IF MORE THAN ONE CASE WILL HAPPEN ON ANY       C
C        DAY, THE SUBROUTINE GENERATES AN EQUIVALENT    C
C        NUMBER OF TIMES, SORTS THEM IN ORDER OF        C
C        ASCENDING SEQUENCE, AND STORES THEM IN AN      C
C        ARRAY CALLED NEXTIM.  AS THE MAIN PROGRAM      C
C        PROCEEDS THROUGH ITS SEQUENCE, IT DETERMINES   C
C        HOW MANY CASES WILL OCCUR (NCASES), AND        C
C        THEN PASSES TO THE SUBROUTINE THE CASE         C
C        NUMBER THAT IT IS CURRENTLY GENERATING         C
C        (NCSE).  THE SUBROUTINE TAKES THIS NUMBER,     C
C        DETERMINES THE HOUR OF OCCURRANCE FOR THAT CASE, C
C        GENERATES A RANDOM MINUTE OF OCCURANCE WITHIN  C
C        THAT HOUR, AND WRITES THIS INFORMATION ON      C
C        ON THE PRINTOUT BEFORE RETURNING TO THE        C
C        MAIN PROGRAM.                                  C
C                                                       C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C
      DIMENSION XTIME(24)
      DIMENSION T(20),TIME(20),NEXTIM(20)
      COMMON /COM2/ISEED
      COMMON /COM10/XTIME
      COMMON /COM11/NCASES
      COMMON /COM22/NTYM
C
      IF(NCASES.GT.1) GO TO 30
      CALL RANDOM (ISEED,TT,1)
      TYME = 100. * TT
      DO 10 I = 1,24
      IF (TYME.LE.XTIME(I)) GO TO 20
   10 CONTINUE
   20 NEXTIM(1) = I - 1
      GO TO 71
C
   30 IF (NCSE.GT.1) GO TO 71
      CALL RANDOM (ISEED,T,NCASES)
      DO 60 J = 1,NCASES
      TIME(J) = 100. * T(J)
      DO 40 I = 1,24
      IF (TIME(J).LE.XTIME(I)) GO TO 50
   40 CONTINUE
   50 NEXTIM (J) = I - 1
   60 CONTINUE
      IEND = NCASES - 1
```

```
      DO 70 M = 1,IEND
      JEND = NCASES - M
C
      DO 70 N = 1,JEND
      IF (NEXTIM(N).LE.NEXTIM(N+1)) GO TO 70
      ITEMP = NEXTIM(N+1)
      NEXTIM(N+1) = NEXTIM(N)
      NEXTIM(N) = ITEMP
C
   70 CONTINUE
   71 CONTINUE
      L = NCSE
      CALL RANDOM (ISEED,TM,1)
      XMINS = 60. * TM
      IF(NEXTIM(L).EQ.24) XMINS = 0
      WRITE (6,100) L,NEXTIM(L),XMINS
  100 FORMAT (/'     CASE ',I2,' TIME OF INCIDENT IS ',I2,
     1F4.0)
      NTYM = NEXTIM(L)
      RETURN
      END
```

```
C
C***********************************************************C
C                                                           C
      SUBROUTINE NATURE
C                                                           C
C***********************************************************C
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                           C
C        THE PURPOSE OF THIS SUBROUTINE IS TO GEN-          C
C        ERATE THE NATURE OF DISTRESS REPRESENTED BY        C
C        THE SAR INCIDENT GENERATED IN THE MAIN PRO-        C
C        GRAM.  EACH SAR INCIDENT OCCURS MORE OR            C
C        LESS RANDOMLY DURING ANY YEAR.  THE CUMU-          C
C        LATIVE DISTRIBUTIONS OF THE SAR OCCURRANCES        C
C        FOR THE YEARS 1970 TO 1974 WERE TABULATED          C
C        AND READ INTO THE MAIN PROGRAM AS (HYST).          C
C        ALONG WITH THESE PERCENTAGES, THE DEGREE           C
C        OF SEVERITY CUMULATIVE PERCENTAGES FOR EACH        C
C        OF THE TYPES OF DISTRESS WERE ALSO TABU-           C
C        LATED AND READ INTO A STORAGE ARRAY (HCUM).        C
C        THIS SUBROUTINE CAN THEREFORE GENERATE A           C
C        RANDOM NUMBER AND USE THIS NUMBER TO DETER-        C
C        MINE THE NATURE OF THE SAR INCIDENT.               C
C        KNOWING THE NATURE OF DISTRESS, THE PRO-           C
C        GRAM GENERATES ANOTHER RANDOM NUMBER AND           C
C        USES THE SECOND NUMBER TO DETERMINE THE            C
C        SEVERITY OF THE DISTRESS. THE NATURE OF            C
C        DISTRESS AND SEVERITY ARE RETURNED TO THE          C
C        MAIN PROGRAM FOR FURTHER USE.                      C
C                                                           C
C                                                           C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      COMMON /COM2/ISEED
      COMMON /COM5/HYST
      COMMON /COM6/HCUM
      COMMON /COM14/ILAND
      COMMON /COM15/IHELCS
      COMMON /COM16/IAIR
      COMMON /COM20/IPER
      COMMON /COM23/NODES
      COMMON /COM24/IPROP
C
      DIMENSION HYST(23),IHURT(16),HCUM(23,16)
C
      CALL RANDOM (ISEED,A,1)
C
C        COMPARE THE RANDOM NUMBER AGAINST THE
C        CUMULATIVE DISTRIBUTION STORED IN ARRAY HYST.
      AINDX = 100.0 * A
      DO 10 K = 1,22
      IF (AINDX.LE.HYST(K)) GO TO 15
   10 CONTINUE
C        DEPENDING ON THE VALUE OF K, BRANCH PROGRAM
C        TO STATEMENT REPRESENTING NATURE OFD
C        TO STATEMENT REPRESENTING NATURE OF DISTRESS.
C
C
   15 IF(K.EQ.1) GO TO 199
      IF(K.EQ.2) GO TO 299
      IF(K.EQ.3) GO TO 399
      IF(K.EQ.4) GO TO 499
      IF(K.EQ.5) GO TO 599
      IF(K.EQ.6) GO TO 699
      IF(K.EQ.7) GO TO 799
      IF(K.EQ.8) GO TO 899
      IF(K.EQ.9) GO TO 999
      IF(K.EQ.10) GO TO 1099
      IF(K.EQ.11) GO TO 1199
      IF(K.EQ.12) GO TO 1299
```

```
      IF(K.EQ.13) GO TO 1399
      IF(K.EQ.14) GO TO 1499
      IF(K.EQ.15) GO TO 1599
      IF(K.EQ.16)GO TO 1699
      IF(K.EQ.17) GO TO 1799
      IF(K.EQ.18) GO TO 1399
      IF(K.EQ.19) GO TO 1999
      IF(K.EQ.20) GO TO 2099
      IF(K.EQ.21) GO TO 2199
      IF(K.EQ.22) GO TO 2299
      IF(K.EQ.23) GO TO 2399
C
C          THIS SECTION PRINTS THE NATURE OF DISTRESS
C          AS WELL AS PERFORMING HOUSEKEEPING FUNCTIONS
C          WHICH ENSURE INTERNAL CONSISTENCY WITHIN THE
C          MODEL.
C
  199 WRITE(6,100)
  100 FORMAT (' NATURE OF DISTRESS IS MISCELLANEOUS ',
     1'VESSEL CONDITION.')
      NODES = 0
      GO TO 9999
  299 WRITE (6,200)
  200 FORMAT (' THE NATURE OF DISTRESS IS VESSEL ADRIFT ',
     1'AND DISABLED.')
      NODES = 1
      GO TO 9999
  399 WRITE (6,300)
  300 FORMAT (' THE NATURE OF DISTRESS IS VESSEL DISABLED ',
     1'AND ANCHORED.')
      NODES = 2
      GO TO 9999
  499 WRITE (6,400)
  400 FORMAT (' THE NATURE OF DISTRESS IS VESSEL AGROUND')
      ILAND = 2
      NODES = 3
      GO TO 9999
  599 WRITE (6,500)
  500 FORMAT (' THE NATURE OF DISTRESS IS VESSEL CAPSIZED.')
      NODES = 4
      GO TO 9999
  699 WRITE (6,600)
  600 FORMAT (' THE NATURE OF DISTRESS IS FIRE OR ',
     1'EXPLOSION ON VESSEL.')
      NODES = 5
      GO TO 9999
  799 WRITE (6,700)
  700 FORMAT (' THE NATURE OF DISTRESS IS VESSEL FLOODING ',
     1'OR SINKING.')
      NODES = 6
      GO TO 9999
  899 WRITE (6,800)
  800 FORMAT (' THE NATURE OF DISTRESS IS OVERDUE OR ',
     1'MISSING VESSEL.')
      NODES = 7
      GO TO 9999
  999 WRITE (6,900)
  900 FORMAT (' THE NATURE OF DISTRESS IS VESSEL ',
     1'COLLISION.')
      NODES = 8
      GO TO 9999
 1099 WRITE(6,1000)
 1000 FORMAT (' THE NATURE OF DISTRESS IS LOST OR ',
     1'DISORIENTATED VESSEL.')
      NODES = 9
      GO TO 9999
 1199 WRITE (6,1100)
 1100 FORMAT (' THE NATURE OF DISTRESS IS VESSEL ' ,
     1'ENDANGERED BY WEATHER.')
      NODES = 11
      GO TO 9999
C
```

```
C
 1299 WRITE (6,1200)
 1200 FORMAT (' THE NATURE OF DISTRESS IS AIRCRAFT ',
     1'CRASHED OR LOST.')
      ILAND = 1
      NODES = 20
      GO TO 9999
 1399 WRITE (6,1300)
 1300 FORMAT (' THE NATURE OF DISTRESS IS LAND VEHICLE ',
     1'CRASHED OR LOST.')
      ILAND = 1
      NODES = 40
      GO TO 9999
 1499 WRITE (6,1400)
 1400 FORMAT (' THE NATURE OF DISTRESS INVOLVES LAND ',
     1'STRUCTURE.')
      ILAND = 1
      NODES = 50
      GO TO 9999
 1599 WRITE (6,1500)
 1500 FORMAT (' THE NATURE OF DISTRESS IS DIVER WITH ',
     1'BENDS  OR LOST.')
      NODES = 70
      GO TO 9999
 1699 WRITE (6,1600)
 1600 FORMAT (' THE NATURE OF DISTRESS IS PERSONNEL ',
     1'MEDEVAC')
      NODES = 80
      GO TO 9999
 1799 WRITE (6,1700)
 1700 FORMAT (' THE NATURE OF DISTRESS IS PERSON DROWNING.')
      NODES = 81
      GO TO 9999
 1899 WRITE (6,1800)
 1800 FORMAT (' THE NATURE OF DISTRESS IS PERSON IN WATER.')
      NODES = 82
      GO TO 9999
 1999 WRITE (6,1900)
 1900 FORMAT (' THE NATURE OF DISTRESS IS PERSONNEL ',
     1'SICKNESS.')
      NODES = 84
      CALL RANDOM (ISEED,Z,1)
      IF (Z.LT.0.5) ILAND = 1
      GO TO 9999
 2099 WRITE (6,2000)
 2000 FORMAT(' THE NATURE OF DISTRESS IS PERSONNEL INJURY.')
      NODES = 85
      CALL RANDOM (ISEED,Z,1)
      IF (Z.LT.0.5) ILAND = 1
      GC TO 9999
 2199 WRITE (6,2100)
 2100 FORMAT (' THE NATURE OF DISTRESS IS PERSON LOST ON ',
     1'LAND.')
      ILAND = 1
      NODES = 87
      GO TO 9999
 2299 WRITE (6,2200)
 2200 FORMAT (' THE NATURE OF DISTRESS IS OTHER ',
     1'MISCELLANEOUS CONDITION.')
      NODES = 90
      GO TO 9999
 2399 WRITE (6,2300)
 2300 FORMAT(' THE NATURE OF DISTRESS IS FLARE SIGHTING.')
      NODES = 98
```

```
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                          C
C        THIS PORTION OF THE SUBROUTINE COMPUTES THE       C
C        SEVERITY OF THE SAR INCIDENT.  THE FOLLOWING      C
C        LABELS ARE USED. . .                              C
C                                                          C
C        IPER  =  THE SEVERITY TO PERSONNEL (0 TO 3)       C
C        IPROP   =  THE SEVERITY TO PROPERTY (0 TO 3)      C
C        IHURT(I)  =  THE DESIGNATOR OF THE GRID           C
C                     USED TO COMPUTE IPER AND IPROP.      C
C                                                          C
C        CODE 0  =  NO SEVERITY TO PERSONS OR PROPERTY     C
C        CODE 1  =  SMALL SEVERITY (LITTLE DANGER)         C
C        CODE 2  =  MODERATE DANGER. MIGHT USE HELO.       C
C        CODE 3  =  GREAT DANGER.  DEFINITELY USE HELO.    C
C                                                          C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C
 9999 DO 20 I = 1,16
      IHURT(I) = I
   20 CONTINUE
      CALL RANDOM(ISEED,P,1)
      HURT = 100. * P
      DO 30 J = 1,16
      IF (HURT.LE.HCUM(K,J)) GO TO 35
   30 CONTINUE
   35 IPER = (IHURT(J) - 1) - ((IHURT(J) - 1)/4 * 4)
      IPROP = (IHURT(J) - 1)/4
      WRITE (6,3000) IPER, IPROP
 3000 FORMAT (' SEVERITY TO PERSONNEL IS ',I2,5X,
     1'SEVERITY TO PROPERTY IS ',I2)
      IF((IPER.LT.2).AND.(IPROP.LT.2)) GO TO 50
      WRITE (6,4000)
 4000 FORMAT(' HELICOPTER WOULD BE USED ON THIS CASE.')
      IHELCS = IHELCS + 1
      IAIR = 1
   50 CONTINUE
      RETURN
      END
```

```
C**********************************************************************C
C                                                                      C
      SUBROUTINE LATLON (IFLAG)
C                                                                      C
C**********************************************************************C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                      C
C                                                                      C
C         THE LATLON SUBROUTINE RECEIVES THE SEED                      C
C         VALUE FROM THE MAIN PROGRAM TO GENERATE A                    C
C         RANDOM NUMBER. IT USES THIS VALUE TO COM-                    C
C         PUTE THE LATITUDE AND LONGITUDE OF THE SAR                   C
C         INCIDENT.  THE SUBROUTINE IS USABLE FOR                      C
C         LATITUDES 41 AND 42N AND LONGITUDES 124-00                   C
C         TO 125-00W.  FOR THE FEW SAR INCIDENTS THAT                  C
C         OCCUR OUTSIDE THIS BOUNDARY, A SEPARATE                      C
C         PROCEDURE IS USED.  THE LATITUDE AND LON-                    C
C         GITUDE ARE COMPUTED USING DIOPHANTINE EQUA-                  C
C         TIONS.  IN THE SUBROUTINE, THE FOLLOWING                     C
C         VARIABLES ARE USED. . .                                      C
C                                                                      C
C         LAT   =  THE LATITUDE OF THE SAR INCIDENT.                   C
C         LONG   =  THE LONGITUDE OF THE SAR INCIDENT.                 C
C         MIN   =  THE MINUTES OF LATITUDE.                            C
C         LMINS   =  THE MINUTES OF LONGITUDE.                         C
C                                                                      C
C                                                                      C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      COMMON /COM1/XCUM
      COMMON /COM2/ISEED
      COMMON /COM7/LAT
      COMMON /COM8/MINS
      COMMON /COM9/LMINS
      COMMON /COM13/DIST
      COMMON /COM14/ILAND
      COMMON /COM20/ IPER
      COMMON /COM21/ MEW
      COMMON /COM24/ IPROP
      COMMON /COM25/LLIND
      COMMON /COM26/ DDDIST
C
      DIMENSION LLIND(288),XCUM(288)
C
C         IF THE INDICATOR ILAND IS EQUAL TO ONE, THE
C         SAR INCIDENT OCCURS INLAND AND THE PROCEDURE
C         FOR GENERATING THE LATITUDE AND LONGITUDE
C         OF THE DISTRESS IN AN OFFSHORE POSITION IS
C         BYPASSED.
C
      DDDIST = 0.
      IF (ILAND.EQ.1) GO TO 99
C
C
      CALL RANDOM (ISEED,XSQR,1)
      SQR = 100. * XSQR + 1.
C
C         THE RANDOM NUMBER IS COMPARED WITH THE
C         ARRAY CONTAINING THE HISTORICAL DISTRIBUTIONS
C         OF SAR INCIDENTS.
C
      DO 50 N = 1,288
      IF(SQR.LE.XCUM(N)) GO TO 60
   50 CONTINUE
C
C         IF THE RANDOM NUMBER IS GREATER THAN THE
C         DISTRIBUTIONS IN THE ARRAY, THE INCIDENT
C         OCCURRED EITHER INLAND OR FARTHER WEST THAN
C         125-00W.  IN THAT CASE, POSITION IS COMPUTED
C         IN A DIFFERENT MANNER.
C
```

```
      IF(SQR.GT.XCUM(N))GO TO 70
C
C        LATITUDE AND LONGITUDE ARE COMPUTED USING
C        THE VALUE OF THE SQUARE IN THE ARRAY WHICH
C        CONTAINED THE RANDOM NUMBER.
C
   60 LONG = 124
      IND = LLIND(N)
      LMINS = (((IND - 1)/24) + 1) * 5
C
C        IF THE INDICATOR ILAND HAS BEEN SET EQUAL TO
C        TO 2, IT INDICATES THAT THE SAR INCIDENT
C        MUST OCCUR ADJACENT TO THE SHRRE, SUCH AS
C        OCCURS WHEN A VESSEL GOES AGROUND.  IN THAT
C        CASE, THE MINUTES OF LONGITUDE ARE CONSTRAINED
C        SO THE POSITION WILL BE NEXT TO THE SHORE.
C
      IF (ILAND.EQ.2) LMINS = 10
      LAT = 40
      ILAT =  ((IND-1) -  ((IND - 1)/24)*24)+ 1
      IF(ILAT.GT.12) LAT = 41
      IF(ILAT.GT.12) ILAT = ILAT - 12
      MINS = 5 * ILAT
      WRITE (6,100) LAT,MINS,LONG,LMINS
  100 FORMAT (' SAR INCIDENT OCCURS LATITUDE ',2I3,
     1' MINS NORTH, LONGITUDE ',2I3,' MINS WEST.')
      GC TO 999
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                            C
C                                                            C
C        IF THE INDICATOR SQR IS GREATER THAN THE            C
C        CUMULATIVE PROBABILITIES STORED IN XCUM             C
C        (THE MAXIMUM OF WHICH IS 94.4) IT MEANS             C
C        THAT THE SAR INCIDENT OCCURRED OUTSIDE THE          C
C        LONGITUDE PARALLELS OF 124-00W AND 124-59W          C
C        THIS OCCURANCE IS SIMULATED IN A RANDOM             C
C        MANNER BECAUSE OF THE ABSENCE OF ADEQUATE           C
C        HISTORICAL DATA SHOWING THE CUMULATIVE              C
C        OCCURANCES.  THE LATITUDE IS RANDOMLY               C
C        GENERATED ASSUMING EQUAL PROBABILITIES              C
C        CAN OCCUR FOR ANY LATITUDE BETWEEN 40-00N           C
C        AND 41-00N.  THE DISTANCE FROM EUREKA IS            C
C        ALSO RANDOMLY GENERATED AND THE DISTANCE            C
C        TO SCENE SUBROUTINE (DISTNC) IS BYPASSED.           C
C                                                            C
C                                                            C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C
   70 CALL RANDOM(ISEED,XL,1)
      XLATN = 12. * XL + 1.
      LLATN = XLATN
      IF(LLATN.GT.6) GO TO 75
      LAT = 40
      MINS = 5 * LLATN
      GO TO 80
   75 LLATN = 12 - LLATN
      LAT = 41
      MINS = 5 * LLATN
   80 CALL RANDOM (ISEED,D,1)
      DIST = 300. * D
C
C        THE DISTANCE OFFSHORE MUST BE GREATER THAN
C        50 MILES OR IT WOULD HAVE OCCURRED WITHIN
C        THE AREA COVERED BY THE GRID XCUM.
C
      IF (DIST.LT.50.) GO TO 80
C
C
C
```

```
      WRITE (6,200) LAT,MINS,DIST
  200 FORMAT(/' SAR INCIDENT OCCURS LATITUDE ', 2I3,
     1' MINS NORTH. DISTANCE TO SCENE IS ',F5.0,'MILES.')
      LMINS = 0
      IFLAG = 1
      IF ((DIST.GE.50.).AND.(DIST.LT.100.)) MEW = 5
      IF ((DIST.GE.100.).AND.(DIST.LT.150.)) MEW = 6
      IF  (DIST.GE.150.)  MEW = 7
      DDDIST = DIST
      IF ((IPER.LT.3).AND.(IPROP.LT.3)) GO TO 90
C
C         IF THE DISTANCE OFFSHORE IS GREATER THAN
C         THE CAPABILITY OF THE HH-52 HELICOPTER,
C         AND THE PROGRAM HAS DECIDED THAT AN AIR-
C         CRAFT IS REQUIRED FOR THE CASE (SEVERITY
C         CODE GREATER THAN 2), THE PROGRAM COMPUTES
C         TIME FOR A HELICOPTER FROM SAN DIEGO TO
C         ARRIVE ON SCENE.
C
      WRITE (6,300)
  300 FORMAT (' DISTANCE TO SCENE IS BEYOND HH-52',
     1' CAPABILITY.')
      ETIME = 6. + DIST / 120.
      WRITE (6,400) ETIME
  400 FORMAT (' TIME REQUIRED FOR HH-3F HELICOPTER',
     1' TO ARRIVE IS ',F3.1,' HOURS.')
      GO TO 999
C
C         TIME FOR A LARGE UNIT FROM HUMBOLT BAY IS
C         COMPUTED.
C
   90 ETIME = DIST / 18.
      WRITE (6,500) ETIME
  500 FORMAT (' TIME FOR A SURFACE UNIT FROM ',
     1'HUMBOLT BAY TO ARRIVE ON SCENE IS ',F4.1,
     2' HOURS.')
      GO TO 999
C
C
C         IN ORDER TO GENERATE A POSITION OF DISTRESS
C         INLAND A BEARING TO THE SCENE FROM THE AIR
C         STATION IS GENERATED AND THEN A RANDOM
C         RANGE IS GENERATED
C
C
   99 CALL RANDOM (ISEED,B,1)
      BRNG = 180. * B
      IBRNG = BRNG
      CALL RANDOM (ISEED,R,1)
      RANGE = 100. * R
      DIST = RANGE
      IRNG = DIST
      WRITE (6,600) IBRNG,IRNG
  600 FORMAT (' INLAND SAR INCIDENT OCCURS BEARING ',
     1I3,' AT A DISTANCE OF ',I3,' MILES FROM AIR STATION.')
      IFLAG = 1
      MEW = 0
      LAT = 0
      MINS = 0
      LMINS = 0
      DDDIST = DIST
      ETIME = DDDIST / 85.
      WRITE (6,700) ETIME
  700 FORMAT (' TIME FOR HELICOPTER FROM ARCATA TO ARRIVE ',
     1'ON SCENE IS ',F4.1,'  HOURS.')
  999 RETURN
      END
```

```
C
C*****************************************************************C
C                                                                 C
      SUBROUTINE DISTNC
C                                                                 C
C*****************************************************************C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                 C
C                                                                 C
C          THIS SUBROUTINE COMPUTES THE DISTANCE FROM             C
C          THE PROPOSED AIR STATION TO THE POSITION               C
C          OF THE SAR INCIDENT GENERATED BY SUBROUTINE            C
C          LATLON.  THE FOLLOWING LABELS ARE USED. . .            C
C                                                                 C
C          XNS = THE DIFFERENCE IN DEGREES OF LATI-               C
C                TUDE BETWEEN THE AIR STATION AND THE SAR         C
C                INCIDENT.  EACH MINUTE OF LATITUDE IS            C
C                EQUIVALENT TO ONE NAUTICAL MILE.                 C
C          XEW = THE DISTANCE TO THE SAR INCIDENT                 C
C                ALONG A PARALLEL OF LATITUDE.  THE               C
C                DEPARTURE, OR THE DISTANCE BETWEEN DEGREES       C
C                OF LONGITUDE, IS TAKEN FROM THE LATITUDE         C
C                OF 41 DEGREES NORTH AND IS 45.28 MILES.          C
C                                                                 C
C          IT IS ASSUMED THAT IF THE DISTANCE OFF -               C
C          SHORE (XEW) IS GREATER THAN 25 MILES THE               C
C          HELICOPTER WOULD FLY PARALLEL TO THE COAST             C
C          AND THEN PROCEED DIRECTLY OFFSHORE WHEN                C
C          AT THE COREECT LATITUDE.  THIS ALTERS THE              C
C          METHOD OF COMPUTING THE DISTANCE TO THE                C
C          SCENE OF THE SAR INCIDENT.                             C
C                                                                 C
C          THIS ALGORITHM IS RESTRICTED TO LATITUDES              C
C          40 AND 41N AND LONGITUDE 124W.                         C
      CONTINUE
C                                                                 C
C          THE POSITION OF EUREKA AIR STATION IS:                 C
C                     41-00N   124-05W                            C
C                                                                 C
C          THE POSITION OF GROUP HUMBOLT BAY MOORING IS:          C
C                     40-47N   124-10W                            C
C                                                                 C
C          THE POSITION OF CRESCENT CITY MOORING IS:              C
C                     41-45N   124-10W                            C
C                                                                 C
C                                                                 C
C                                                                 C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      COMMON /COM7/LAT
      COMMON /COM8/MINS
      COMMON /COM9/LMINS
      COMMON /COM13/DIST
      COMMON /COM14/ILAND
      COMMON /COM16/IAIR
      COMMON /COM21/MEW
      MMINS = 0
C
      IF (IAIR.EQ.0) GO TO 30
C
C        COMPUTE DISTANCE FOR HELICOPTER FROM AIR STA
C
      IF (LAT.EQ.40) XNS = 60. - MINS
      XMINS = LMINS
      XEW = 45.28 * ABS(XMINS - 10.0)/60.0
      IF (XEW.GT.25.0) GO TO 10
      DIST = ((XNS ** 2.) + (XEW ** 2.)) ** 0.5
      GO TO 20
   10 DIST = XNS + XEW
   20 WRITE (6,100) DIST
  100 FORMAT(' DISTANCE FROM AIR STA TO POSITION',
```

```
     1' OF SAR INCIDENT IS  ',F8.2, ' MILES.')
      ETIME = DIST/85.0
      WRITE (6,150) ETIME
  150 FORMAT (' ENROUTE TIME FOR HELICOPTER TO ',
     1'SCENE OF DISTRESS IS ',F3.1, ' HOURS.')
C
C
C          DECIDE ON CLOSEST SURFACE UNIT.
C
   30 IF ((LAT.EQ.41).AND.(MINS.GT.30)) GO TO 50
C
C          COMPUTE DISTANCE TO SCENE FOR SURFACE UNIT
C          FROM HUMBOLT BAY.
C
      XNS = 0.
      IF ((LAT.EQ.40).AND.(MINS.GT.47)) XNS = MINS - 47.
      IF (XNS.GT.0) GO TO 40
      XNS = 47. - MINS
   40 XMINS = LMINS
      XEW = 45.28 * (XMINS - 10.)/60.0
      DIST = ((XNS ** 2.) + (XEW ** 2.)) ** 0.5
      WRITE (6,200) DIST
  200 FORMAT (' THE DISTANCE TO SCENE FOR A ',
     1'SURFACE UNIT FROM HUMBOLT BAY IS ',F5.1)
      STIME = DIST/18.0
      WRITE (6,250) STIME
  250 FORMAT (' THE TIME REQUIRED FOR A SURFACE ',
     1'UNIT TO ARRIVE ON SCENE IS ',F3.1,' HOURS.')
      GO TO 60
C
C
C          COMPUTE DISTANCE TO SCENE FROM CRESCENT CITY.
C
   50 IF (MINS.LT.45) GO TO 55
      XNS = MINS - 45.
      GO TO 56
   55 XNS = 45. - MINS
   56 XMINS = LMINS
      XEW = 45.28 * ABS(XMINS - 10.0)/60.0
      DIST = ((XNS ** 2.) + (XEW ** 2.)) ** 0.5
      WRITE (6,300) DIST
  300 FORMAT (' THE DISTANCE TO SCENE FROM CRESCENT ',
     1'CITY IS ',F5.1,' MILES.')
      STIME = DIST/18.0
      WRITE (6,250) STIME
   60 WRITE (6,400)XEW
  400 FORMAT(' THE DISTANCE OFFSHORE IS ',F5.1,' MILES')
   80 CONTINUE
      IF ((XEW.GE.0.).AND.(XEW.LE.3.)) MEW = 1
      IF ((XEW.GT.3.).AND.(XEW.LE.10.)) MEW = 2
      IF ((XEW.GT.10.).AND.(XEW.LE.25.)) MEW = 3
      IF ((XEW.GT.25.).AND.(XEW.LE.50.)) MEW = 4
      IF ((XEW.GT.50.).AND.(XEW.LE.100.)) MEW = 5
      IF ((XEW.GT.100.).AND.(XEW.LE.150.)) MEW = 6
      IF (XEW.GT.150.) MEW = 7
      RETURN
      END
```

```
C***********************************************************C
C                                                           C
      SUBROUTINE WEATHR
C                                                           C
C***********************************************************C
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                           C
C                                                           C
C        THIS SUBROUTINE COMPUTES THE WEATHER CON-          C
C        DITIONS AT THE SCENE OF THE SAR INCIDENT           C
C        WHICH WAS GENERATED IN THE MAIN PROGRAM.           C
C        THE CUMULATIVE DISTRIBUTIONS OF THE WEA-           C
C        THER CONDITIONS ARE BASED UPON THE HIS-            C
C        TORICAL WEATHER AT ALL SCENES OF SAR               C
C         INCIDENTS FOR THE YEARS 1970 TO 1974.             C
C                                                           C
C         THE VARIABLE LABELS USED IN THIS SUBROUTINE       C
C        ARE AS FOLLOWS. . .                                C
C                                                           C
C        ISTATE  =  THE CELL NUMBER FOR THE WEATHER         C
C                   CONDITIONS.  IT IS DERIVED BY           C
C                   GENERATING A RANDOM NUMBER AND          C
C                   COMPARING THIS NUMBER WITH THE          C
C                   HISTORICAL CUMULATIVE PERCENTAGES       C
C                   FOR THE WEATHER CONDITIONS.             C
C        IWIND  =  THE WIND STATE CODE (0 TO 8).            C
C        ISEA  =  THE SEA STATE CODE (0 TO 8).              C
C        IVIZ  =  THE VISIBILITY STATE CODE (0 TO 8).       C
C                                                           C
C                                                           C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      DIMENSION ISTATE (729), WXNR(729)
C
      COMMON /COM2/ISEED
      COMMON /COM3/ISTATE
      COMMON /COM4/WXNR
      COMMON /COM14/ILAND
      COMMON /COM17/ ISEA
      COMMON /COM18/IWIND
      COMMON /COM19/IVIZ
C
    5 CALL RANDOM(ISEED,W,1)
      WX = 100. * W
      DO 20 I = 1,729
      IF(WX.LE.WXNR(I)) GO TO 25
   20 CONTINUE
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                           C
C        THE GRID FOR THE WEATHER CONDITIONS AT THE         C
C        THE SCENE OF THE SAR INCIDENT HAS THE              C
C        FOLLOWING  DIMENSIONS. . .                         C
C                                                           C
C        SEA STATE (ISEA)  X-AXIS WITH DIMENSION 9          C
C                          (0 TO 8)                         C
C        WIND (IWIND) Y-AXIS WITH DIMENSION 9 (0 TO 8)      C
C        VISIBILITY (IVIZ) Z-AXIS WITH DIMENSION 9          C
      CONTINUE
```

```
C                                                           C
C        USING DIOPHANTINE EQUATIONS, WE CAN DERIVE         C
C        THE CODE FOR THE WIND, SEA, AND VISIBILITY         C
C        KNOWING THE CELL NUMBER (ISTATE) REPRESENTING      C
C        THE JUNCTION OF THE THREE CODES.  THIS             C
C        CELL NUMBER IS GENERATED RANDOMLY WHEN "W"         C
C        IS GENERATED ABOVE.  THE GENERAL EQUATION          C
C        FOR THIS CELL NUMBER GIVEN THE VALUES OF           C
C        THE THREE AXIS IS "L  =  NM(K-1) + N(J-1)          C
C        + I WHERE IN THIS EQUATION L IS ISTATE(I),         C
C        N = 9 (THE NUMBER OF ROWS), M = 9 (THE             C
C        NUMBER OF COLUMNS) AND K IS THE "Z" AXIS           C
C        VARIABLE, J IS THE "X" AXIS VARIABLE, AND          C
C        I IS THE "Y" AXIS VARIABLE.  THE BASIC             C
C        EQUATIONS TO DETERMINE EACH OF THESE VALUES        C
C        ARE AS FOLLOWS. . .                                C
      CONTINUE
C                                                           C
C        J  =  (L-NM(K-1)-1)/N + 1                          C
C        K  =  (L-1)NM + 1                                  C
C        I  =  (L-NM(K-1)-1) - ((L-NM(K-1)-1)/N*N)+1        C
C                                                           C
C        THESE EQUATIONS MUST BE ALTERED IN THE             C
C        MODEL FOR THE AIR STATION SIMULATION BE-           C
C        CAUSE SOME OF THE ALLOWABLE CODES ARE              C
C        ZERO AND THE BASIC EQUATIONS GIVE VALUES           C
C        GREATER THAN ONE.  IN ORDER TO TAKE INTO           C
C        ACCOUNT THE FACT THAT ZEROES ARE PRESENT,          C
C        THE "+1" FACTOR IS DROPPED FROM EACH EQUA-         C
C        TION AND THE "K-1" FACTOR FOR "J" AND              C
C        "I" EQUATIONS IS CHANGED TO SIMPLY "K".            C
C                                                           C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
   25 NM = 81
      N = 9
C
      IVIZ = (ISTATE(I) - 1)/NM
      IWIND = (ISTATE(I) - NM*(IVIZ)-1)/N
      ISEA=(ISTATE(I)-NM*(IVIZ)-1)-(((ISTATE(I)-NM*(IVIZ)-1)
     1/N)*N)
      IF (ISEA.EQ.8) GO TO 5
      IF(ILAND.EQ.1) ISEA=8
C
      WRITE(6,200) IVIZ,IWIND,ISEA
  200 FORMAT (' THE VISIBILITY ON SCENE IS CODE ',I2,
     1' THE WIND ON SCENE IS CODE ',I2,/
     2' THE SEA STATE ON SCENE IS CODE ',I2)
      RETURN
      END
```

```
C
C
C
C                  A PROGRAM TO COMPUTE RESPONSE TIMES
C
C                              USING
C
C                        COMPUTER-SIMULATION DATA
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                            C
C                                                            C
C        SFRAN AIR STATION              37-37N    122-20W    C
C        ARCATA AIR STATION             41-00N    124-05W    C
C        HUMBOLT BAY MOORINGS           40-47N    124-10W    C
C        CRESCENT CITY MOORINGS         41-45N    124-10W    C
C                                                            C
C                                                            C
      CONTINUE
C                                                            C
C        THIS PROGRAM COMPUTES THE RESPONSE TIMES FOR        C
C        COAST GUARD UNITS TO ARRIVE ON SCENE FOR            C
C        SEARCH AND RESCUE INCIDENTS.  THE POSITION          C
C        OF THE INCIDENTS AND THE SEVERITY IS READ           C
C        FROM PUNCHED CARDS.  IF THE INCIDENT OCCURS         C
C        ON LAND, THE PROGRAM BRANCHES AND DOES NOT          C
C        CONSIDER RESPONSE BY SURFACE UNITS.  THE            C
C        PROGRAM DETERMINES RESPONSE TIMES FROM THE          C
C        PROPOSED COAST GUARD AIR STATION AT ARCATA AS       C
C        WELL AS THE PRESENT AIRBORNE CAPABILITIES OF        C
C        THE COAST GUARD IN SAN FRANCISCO.  AS AN            C
C        ALTERNATE POSSIBILITY, THE RESPONSE TIMES           C
C        FOR HH-3F HELICOPTERS LOCATED IN SAN FRANCISCO      C
C        ARE ALSO CALCULATED.                                C
      CONTINUE
C        THE DECISION CRITERIA USED IS THAT A HELI-          C
C        COPTER FROM ARCATA WOULD RESPOND TO A DISTRESS      C
C        INCIDENT IF THE REPORTED SEVERITY WAS MODERATE      C
C        OR SEVERE (CODE 2 OR 3).  A HELICOPTER              C
C        WOULD RESPOND FROM SAN FRANCISCO ONLY IF THE        C
C        SEVERITY WAS CODE 3.  THE PROGRAM DETERMINES        C
C        RESPONSE TIME FOR EACH FACILITY ACCORDING TO        C
C        THESE CRITERIA AND PRINTS THEM.  IT THEN            C
C        DETERMINES MINIMUM RESPONSE TIME FOR A DISTRESS     C
C        WITH AND WITHOUT THE PRESENCE OF THE                C
C        PROPOSED COAST GUARD AIR STATION AT ARCATA.         C
C                                                            C
C                                                            C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C
      WRITE (6,400)
  400 FORMAT (///'                         COAST GUARD ',
     1'RESPONSE TIMES--SIMULATED DATA'///)
      WRITE (6,300)
  300 FORMAT (' CASE       HUMBOLT BAY      CRESCT CITY',
     1'       ARCATA AIR     SFRAN AIR    MINIMUM    OLD',
     2' MINIMUM    LAND'//)
C
C        TOTALS ARE SET TO ZERO.
C
      TCT = 0.
      TCTNEW = 0.
      TOTH3 = 0.
      TOTHH3 = 0.
      NRLAND = 0
      NRHH3 = 0
      NRFAR = 0
      TCT2 = 0.
      TCT3 = 0.
      TCTNU2 = 0.
      TOTNU3 = 0.
```

```
      XMCD = 0.
      XSEV = 0.
C
C
      OVER1 = 0.
      OVER5 = 0.
      GREAT5 = 0.
      GREAT1 = 0.
      MORE5 = 0
      MORE1 = 0
      CCAST = 0.
C
C
C        COMPUTATION BEGINS.
C
C
      DO 990 J = 1,NUMB
C
C        TOTALS ARE SET TO ZERO FOR EACH CASE.
C
      LAND = 0
      HDIST = 0.
      HTIME = 0.
      CDIST = 0.
      CTIME = 0.
      ADIST = 0.
      ATIME = 0.
      SFDIST = 0.
      SFTIME = 0.
      PTIME = 0.
      CEW = 0.
      AEW = 0.
      SFEW = 0.
      HEW = 0.
      UTIME = 0.
C
C
   10 READ (5,100) PLAT,PMINS,PLMINS,IPER,IPROP,ISEA,DDDIST
  100 FORMAT (34X,2F2.0,3X,F2.0,1X,2I1,1X,I1,5X,F3.0)
C
C        CHECK FOR LAND CASE BY EXAMINING ISEA VALUE.
C        IF LAND CASE, BRANCH TO AIR STATION COMPU-
C        TATIONS.  INCREMENT LAND CASE COUNTER.
C
      IF (ISEA.EQ.8) NRLAND = NRLAND + 1
      IF (ISEA.EQ.8) GO TO 40
C
C        IF DISTANCE OFFSHORE IS GREATER THAN 100 MILES,
C        INCREMENT COUNTER BY ONE.  THIS CASE WOULD BE
C        HANDLED BY A HH-3F.
C
      IF (DDDIST.GT.100.) NRHH3 = NRHH3 + 1
      HEW = DDDIST
C
C
C        COMPUTE DISTANCE TO SCENE FROM HUMBOLT BAY MOORINGS
C
      IF (PLAT.EQ.41.) HNS = PMINS + 13.
      IF (PLAT.EQ.41.) GO TO  20
      IF (PMINS.GT.47.) HNS = PMINS - 47.
      IF (PMINS.LE.47.) HNS = 47. - PMINS
   20 IF (PLMINS.GT.10.) HEW = (PLMINS - 10.) * 0.7547
      IF (PLMINS.LE.10.) HEW = (10. - PLMINS) * 0.7547
      HDIST = SQRT(HNS ** 2 + HEW ** 2)
      IF (DDDIST.GT.0.) HDIST = SQRT(HNS ** 2 + DDDIST ** 2)
      HTIME = HDIST / 18.
C
```

```
C
C        COMPUTE DISTANCE TO SCENE FROM CRESCENT CITY
C
      IF (( PLAT.EQ.41.).AND.(PMINS.GE.45.)) CNS =
     1 (PMINS - 45.)
      IF (( PLAT.EQ.41.).AND.(PMINS.LT.45.)) CNS =
     1 (PMINS - 45.)
      IF (PLAT.EQ.40.) CNS = 45. + (60. - PMINS)
      CEW = HEW
      CDIST = SQRT (CNS ** 2 + CEW ** 2)
      IF (DDDIST.GT.0.) CDIST = SQRT(CNS ** 2 + DDDIST ** 2)
     1 ** 0.5
      CTIME = CDIST / 18.
C
C
C        COMPUTE SAN FRANCISCO AIR STATION DISTANCE
C
C        IF SEVERITY CODE LESS THAN 3, AIRCRAFT
C        FROM SAN FRANCISCO WOULD NOT RESPOND.
C        PROGRAM BRANCHES TO ARCATA AIR STATION.
C
   40 IF ((IPER.LT.3).AND.(IPROP.LT.3)) GO TO 60
      IF (ISEA.EQ.8) GO TO 47
      SFEW = DDDIST
      IF (PLAT.EQ.41.) SFNS = PMINS
      IF (PLAT.EQ.40.) SFNS = 60. - PMINS
C
C        IF THE DISTANCE OFFSHORE OF THE DISTRESS IS
C        LESS THAN 100 MILES, ASSUME THAT AN HH-52
C        CAN BE USED IF IT IS ESCORTED BY A FIXED-WING
C        AIRCRAFT FROM SAN FRANCISCO. ONE HOUR IS
C        ADDED TO TRANSIT TIME FROM SAN FRANCISCO
C        FOR THE HELICOPTER TO REFUEL IN ARCATA.
C
      IF ((DDDIST.GT.0.).AND.(DDDIST.LT.100.)) SFTIME =
     1 3.7 + (SQRT(DDDIST ** 2 + SFNS ** 2) / 85.)
C
C        RESPONSE TIME FOR SAN FRANCISCO HH-3F IS
C        CALCULATED.  NO ESCORT FOR THIS HELICOPTER
C        IS REQUIRED.
C
C
      IF ((DDDIST.GT.0.).AND.(DDDIST.LT.100.))PTIME =
     1(SQRT(44100. + DDDIST ** 2) / 120.)
      IF (( DDDIST.GT.0.).AND.(DDDIST.LT.100.)) GO TO 49
      IF (DDDIST.GT.0.) GO TO 47
      IF (PLMINS.GT.5.) SFEW = (PLMINS - 5.) * 0.7547
      IF (PLMINS.LE.5.) SFEW = (5. - PLMINS) * 0.7547
      IF (SFEW.GT.25.) GO TO 43
      SFDIST = SQRT (SFNS ** 2 + SFEW ** 2)
      GO TO 45
   43 SFDIST = SFNS + SFEW
   45 SFTIME = 3.7 + SFDIST / 85.
      PTIME = 1.75 + SFDIST / 120.
      GO TO 49
C
C        CALCULATE RESPONSE TIMES FOR LAND CASES.
C
   47 IF (ISEA.EQ.8) SFTIME = 3.7 + DDDIST / 85.
      IF (ISEA.EQ.8) PTIME = 1.75 + (DDDIST / 120.)
      IF (ISEA.EQ.8) GO TO 49
C
C        NOTE: THIS TIME BASED ON 3 HOURS FOR HELO TO GET TO
C        SAN FRANCISCO FROM SAN DIEGO OR ASTORIA PLUS 1
C        HOUR FOR REFUEL PLUS 2 HOURS FROM SAN FRANCISCO TO
C        ARCATA.  MISSION THEN PROCEEDS FROM THERE.
C        THIS DELAY NOT NECESSARY IF HH-3F HELO
C        STATIONED AT SAN FRANCISCO
C
      SFTIME = (SQRT(DDDIST ** 2 + SFNS ** 2) / 120.) + 6.
      PTIME = 1.75 + (SQRT(DDDIST ** 2 + SFNS ** 2) / 120.)
   49 CONTINUE
```

```
C
C
C          COMPUTE DISTANCE FROM ARCATA
C
C
C          CHECK FOR LAND CASE.  IF SEVERITY CODE
C          LESS THAN 2, BYPASS THIS SEGMENT.
C
C
   60 IF (ISEA.EQ.8) GO TO 65
      IF ((IPER.LT.2).AND.(IPROP.LT.2)) GO TO 80
      AEW = DDDIST
      IF (PLAT.EQ.41.) ANS = PMINS
      IF (PLAT.EQ.40.) ANS = 60. - PMINS
C
C          IF THE DISTANCE OFFSHORE IS LESS THAN 100
C          MILES, IT IS ASSUMED THAT A HH-52 HELICOPTER
C          FROM ARCATA COULD BE USED IF IT IS ESCORTED
C          BY A FIXED-WING AIRCRAFT FROM SAN FRANCISCO.
C          ONE AND ONE-HALF HOURS DELAY TIME IS ADDED
C          TO ACCOUNT FOR THE TIME TO GET THE FIXED-
C          WING AIRCRAFT TO ARCATA.
C
      IF ((DDDIST.GT.0.).AND.(DDDIST.LT.100.)) ATIME =1.5 +
     1 (SQRT(DDDIST ** 2 + ANS ** 2) / 85.)
      IF ((DDDIST.GT.0.).AND.(DDDIST.LT.100.)) GO TO 69
      IF (DDDIST.GT.0.) GO TO 67
      IF (PLMINS.GT.5.) AEW = (PLMINS - 5.) * 0.7547
      IF (PLMINS.LE.5.) AEW = (5. - PLMINS) * 0.7547
C
C          IF THE DISTANCE OFFSHORE IS GREATER THAN 25
C          MILES, THE COUNTER IS INCREASED BY ONE.
C
      IF (AEW.GT.25.) NRFAR = NRFAR + 1
      IF (AEW.GT.25.) GO TO 63
      ADIST = SQRT(ANS ** 2 + AEW ** 2)
      GO TO 65
   63 ADIST = ANS + AEW
   65 ATIME = 0.
      IF (AEW.LT.25.) ATIME = ADIST / 85.
      IF ((AEW.GT.25.).AND.(AEW.LT.100.)) ATIME =
     1 1.5 + ADIST / 85.
      IF (ISEA.EQ.8) ATIME = DDDIST / 85.
      GO TO 69
   67 ATIME = 6. + (SQRT (DDDIST ** 2 + ANS ** 2) / 120.)
      IF (DDDIST.GT.100.) NRHH3 = NRHH3 + 1
   69 CONTINUE
C
C
C          THE VALUES OF TIME ARE MADE VERY LARGE IF THEY ARE
C          EQUAL TO ZERO IN ORDER THAT THE COMMAND TO SELECT
C          THE MINIMUM VALUE FOR RESPONSE TIME WILL NOT
C          SELECT A ZERO VALUE
C
C
   80 HTYME = HTIME
      CTYME = CTIME
      ATYME = ATIME
      SFTYME = SFTIME
      PTYME = PTIME
      IF (HTIME.EQ.0.) HTYME = 999.
      IF (CTIME.EQ.0.) CTYME = 999.
      IF (ATIME.EQ.0.) ATYME = 999.
      IF (SFTIME.EQ.0.) SFTYME = 999.
      IF (PTIME.EQ.0.) PTYME = 999.
      IF (HDIST.EQ.0.) HDIST = 999.
      IF (CDIST.EQ.0.) CDIST = 999.
      IF (SFDIST.EQ.0.) SFDIST = 999.
      IF (ADIST.EQ.0.) ADIST = 999.
```

```
C
C          MINIMUM DISTANCE OFFSHORE IS CALCULATED.
C
      DIST = AMIN1 (HEW,AEW)
      IF (DIST.LE.150.) COAST = COAST + 1
C
C          MINIMUM TIME TO RESPOND WITH ARCATA AIR
C          STATION IS CALCULATED.
C
      STIME = AMIN1(HTYME,CTYME,ATYME,SFTYME)
C
C          MINIMUM TIME TO RESPOND WITHOUT ARCATA AIR
C          STATION IS CALCULATED.
C
      TTIME = AMIN1(HTYME,CTYME,SFTYME)
C
C          MINIMUM TIME TO RESPOND WITH HH-3F AT
C          SAN FRANCISCO IS CALCULATED.
C
      UTIME = AMIN1 (HTYME,CTYME,PTYME)
C
C          RELATIVE EFFECT OF THREE ALTERNATIVES IS
C          TALLIED.  OVER5 INDICATES RESPONSE TIME
C          WAS GREATER THAN ONE-HALF HOUR.  OVER1
C          INDICATES THAT RESPONSE TIME IS GREATER
C          THAN ONE HOUR IN THE COASTAL ZONE.
C
      IF ((DIST.LE.150.).AND.(TTIME.GT.0.5)) OVER5 =
     1 OVER5 + 1
      IF ((DIST.LE.150.).AND.(TTIME.GT.1.)) OVER1 =
     1 OVER1 + 1
      IF ((DIST.LE.150.).AND.(STIME.GT.1.)) GREAT1 =
     1 GREAT1 + 1.
      IF ((DIST.LE.150.).AND.(STIME.GT.0.5)) GREAT5 =
     1 GREAT5 + 1
      IF ((DIST.LE.150.).AND.(UTIME.GT.0.5)) MORE5 =
     1 MORE5 + 1
      IF ((DIST.LE.150.).AND.(UTIME.GT.1.)) MORE1 =
     1 MORE1 + 1
      IF(ISEA.EQ.8) LAND = 1
      IF (STIME.GT.100.) STIME = 0.
      IF (TTIME.GT.100.) TTIME = 0.
      IF (UTIME.GT.100.) UTIME = 0.
C
C          SEVERITY TO INCIDENTS IS TALLIED.
C
      IF ((IPER.EQ.3).OR.(IPROP.EQ.3)) GO TO 83
      IF ((IPER.EQ.2).OR.(IPROP.EQ.2)) XMOD = XMOD + 1.
      IF ((IPER.EQ.2).OR.(IPROP.EQ.2)) TOT2 = TOT2 + TTIME
      IF ((IPER.EQ.2).OR.(IPROP.EQ.2)) TOTNU2 =
     1 TOTNU2 + STIME
   83 IF ((IPER.EQ.3).OR.(IPROP.EQ.3)) XSEV = XSEV + 1.
      IF ((IPER.EQ.3).OR.(IPROP.EQ.3)) TOT3 = TOT3 + TTIME
      IF ((IPER.EQ.3).OR.(IPROP.EQ.3)) TOTNU3 = TOTNU3 +
     1 STIME
      IF ((IPER.EQ.3).OR.(IPROP.EQ.3)) TOTH3 = TOTH3 + UTIME
C
C
      WRITE (6,200) J,HTIME,CTIME,ATIME,SFTIME,STIME,TTIME,
     1 LAND,IPER,IPROP
  200 FORMAT (2X,I3,10X,F5.2,10X,F5.2,10X,F5.2,10X,F5.2,10X,
     1 F5.2,8X,F5.2,8X,I1,10X,2I1)
      WRITE (6,220) PTIME,UTIME
  220 FORMAT (59X,F5.2,9X,F6.2)
      WRITE (7,222) STIME,TTIME,UTIME,LAND
  222 FORMAT (3F10.2,10X,I1)
C
C
      TOT = TOT + TTIME
      TOTNEW = TOTNEW + STIME
      TOTHH3 = TOTHH3 + UTIME
  990 CONTINUE
```

```
C
C          AVERAGE RESPONSE TIMES ARE CALCULATED.
C
      AVOLD = TOT / NUMB
      AVNEW = TOTNEW / NUMB
      AVHH3 = TOTHH3 / NUMB
C
      WRITE (6,400)
      WRITE (6,500) AVOLD
  500 FORMAT (//' WITHOUT ARCATA CGAS THE AVERAGE RESPONSE',
     1' TIME IS ',F5.2,' HOURS.')
      WRITE (6,600) AVNEW
  600 FORMAT(//' WITH COAST GUARD AIR STATION AT ARCATA',
     1' AVERAGE RESPONSE TIME IS ',F5.2,' HOURS.')
      WRITE (6,550) AVHH3
  550 FORMAT (//' WITH HH3F AT SFRAN, AVERAGE RESPONSE TIME
     1'IS: ',F5.2,' HOURS.')
      WRITE (6,700) NRLAND
  700 FORMAT (//' THE NUMBER OF CASES ON LAND IS: ',I2)
      WRITE (6,800) NRFAR
  800 FORMAT (//' THE NUMBER OF CASES OFFSHORE REQUIRING',
     1' ESCORT IS: ',I4)
      WRITE (6,900) NRHH3
  900 FORMAT (//' THE NUMBER OF OFFSHORE CASES GREATER THAN'
     1' 100 MILES IS: ',I4)
C
C
      RES2 = TOT2 / XMOD
      RESNU2 = TOTNU2 / XMOD
      RES3 = TOT3 / XSEV
      RESNU3 = TOTNU3 / XSEV
      RES3F = TOTH3 / XSEV
      RES23 = (TOT2 + TOT3)/(XMOD + XSEV)
      RENU23 = (TOTNU2 + TOTNU3)/(XMOD + XSEV)
      RES23F = (TOT2 + TOTH3) / (XMOD + XSEV)
      WRITE (6,1400) RES2,RESNU2
 1400 FORMAT (//' AVERAGE RESPONSE TIME TO MODERATE-DANGER',
     1' CASES WITHOUT ARCATA AIR: ',F5.2,'  WITH ARCATA ',
     2'AIR STATION: ',F5.2,' HOURS.')
      WRITE (6,1100) RES3,RESNU3,RES3F
 1100 FORMAT (//' AVERAGE TIME TO RESPOND TO SEVERE-DANGER',
     1' CASES WITHOUT ARCATA AIR: ',F5.2,' WITH ARCATA ',
     2'AIR: ',F5.2,'  WITH SFRAN H3F: ',F5.2,' HOURS.')
      WRITE (6,1200) RES23,RENU23,RES23F
 1200 FORMAT (//' AVERAGE RESPONSE TIME-MODERATE/SEVERE',
     1' CASES WITHOUT ARCATA AIR: ',F5.2,'  WITH ARCATA ',
     2'AIR STATION: ',F5.2,' WITH SFRAN H3F: ',F5.2,
     3' HOURS.')
      WRITE (6,1300) XMOD,XSEV
 1300 FORMAT (//' NUMBER OF CASES   MODERATE: ',F4.0,
     1'    SEVERE:  ',F4.0)
      WRITE (6,1500)COAST
 1500 FORMAT (//' THE NUMBER OF CASES IN THE COASTAL',
     1' ZONE IS: ',F5.0)
      WRITE (6,1600)
 1600 FORMAT (//' THE NUMBER OF CASES IN THE COASTAL ZONE',
     1' IN WHICH RESPONSE TIME WAS GREATER THAN',
     2' ONE-HALF HOUR IS: ')
      WRITE (6,1660) OVER5,GREAT5,MORE5
 1660 FORMAT (' WITHOUT ARCATA AIR: ',F4.0,,
     1'  WITH ARCATA AIR: ',F4.0,'  WITH SFRAN H3F: ',I4)
      WRITE (6,1700)
 1700 FORMAT (//' THE NUMBER OF COASTAL CASES IN WHICH',
     1' RESPONSE TIME WAS GREATER THAN ONE HOUR IS: ')
      WRITE (6,1760) OVER1,GREAT1,MORE1
 1760 FORMAT (' WITHOUT ARCATA AIR:  ',F4.0,
     1'  WITH ARCATA AIR: ',F4.0,'  WITH SFRAN H3F: ',I4)
      STOP
      END
```

FOOTNOTES

[1] United States Coast Guard, *Aviation Plan, 1974-1984 (CG-38 C-2)* (Washington: 1973), p. I-SAR-5.

[2] Ibid, p. I-SAR-24.

[3] Ibid., p. II-LOCTN-12.

[4] Ibid., p. II-STA-88.

[5] United States Department of Commerce, *Local Climatological Data for 1972*, (Ashville: 1972), (no page numbers).

[6] State of California, Department of Motor Vehicles. *Boat Registrations: Number of Boats Registered to Date.* (Sacramento: 1969 through 1974).

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